Translating and validating a Mandarin Chinese version of the Computerized Revised Token Test

by

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Introduction: Speech-language pathology is a relatively new clinical discipline in Taiwan. There is a paucity of standardized assessment tools available in Mandarin Chinese. For example, there is one standardized test for aphasia, the Concise Chinese Aphasia Test (CCAT). Because no single assessment tool can serve all assessment purposes, it is important to develop new assessment tools to meet various clinical needs. One test that is culturally neutral, provides easy translation and has a long history of successful psychometric development is the Revised Token Test (RTT). This test has been computerized (Computerized-RTT – CRTT) and was selected for translation and validation in Mandarin Chinese.

The primary purpose of this study was to investigate the concurrent validity of the translated CRTT by comparing the performance of normal participants and persons with aphasia (PWA) on this test, to their performance on the CCAT.

Method and Procedures: The translation of the CRTT (CRTT-Mandarin) was first validated. This translation was recorded auditorily by a native speaker and the recording was assessed for articulatory and prosodic accuracy. The CCAT and the CRTT-Mandarin were administered to 11 PWA, and 19 normal individuals. All participants were native Chinese speakers, between 38 and 80 years of age, and without premorbid history of speech, language, hearing or learning disorders. Participants were

assigned the CRTT-Mandarin and the CCAT randomly and all participants finished the two tests within ten days.

Results: Statistical analyses revealed significant differences between groups on the overall and subtest scores of the CRTT-Mandarin. Correlation coefficients computed between the CRTT-Mandarin overall and between subtest scores and each of the CCAT subtest and overall scores were low and nonsignificant for both participant. However, when the groups were combined, the correlations were predominantly high (>.70) and significant ($p<.05$).

Discussion: The CRTT-Mandarin distinguished comprehension performance between PWA and normal controls. This finding, along with the high correlations between the CRTT-Mandarin and the CCAT, provide preliminary concurrent validity for the CRTT-Mandarin. Small sample sizes are a substantive limitation of the study. Future work will establish additional concurrent validity, reliability, sensitivity, specificity, and other psychometric data for the test using larger sample sizes.

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PREFACE

This thesis is the first research project of my professional career; it may be small but it is a milestone for me. I considered the process one of self-discipline. As a second-language speaker of English, the writing was extremely difficult. There were many times that I almost gave up. Several people helped me, encouraged me to complete this task and deserve special acknowledgment and many thanks. My thesis supervisor, Malcolm McNeil, has provided advice and has helped me become a better thinker. François-Xavier Brajot, has been my mentor for several years and has always talked to me at midnight. Kristopher Geda, a smart linguist helped me rewrite my papers all the time and never complained. Amanda Kroboth, has been a good friend and good company while I wrote this thesis. Chiung-Hui Chiu, has been there always, even if there were twelve hours time difference. Last but certainly not least, my parents, my brother, and my sister. Each helped me to finish the program and the research in every aspect. Any good attributed to me is really theirs.

1.0 INTRODUCTION

Similar to many countries in Asia, Taiwan has for the past three decades embraced and developed speech-language pathology as a new health profession. Because speech-language pathology is a relatively new clinical discipline in Taiwan, there are a limited number of standardized assessment tools available in either the native language of Taiwanese or in Mandarin Chinese. There is only one standardized assessment tool that is available to speech-language pathologists for use with persons with aphasia, the Concise Chinese Aphasia Test (CCAT; Zhong, Li & Zhang, 2003).

The CCAT was modeled on the Porch Index of Communicative Ability (PICA; Porch, 1971) and was developed with multidimensional scoring. It includes nine subtests and 90 test items in total. The CCAT assesses the primary communication modalities and several linguistic functions. Psychometrically, it is a well-developed and standardized test for use in clinical settings. Test stimuli are quotidian in nature. However, like the PICA, it provides a limited, and perhaps an inadequate assessment of listening and reading comprehension.

Auditory comprehension is a foundation of communication and language learning. The Revised Token Test (RTT; McNeil & Prescott, 1978) is one of the most well-researched assessment tools for auditory comprehension. The RTT contains 10 subtests and 10 imperative commands per subtest. It uses a multidimensional scoring system to provide detailed information about the patients' auditory comprehension ability. The test stimuli in the RTT are not affected by gender, educational level, special language knowledge and it appears to be culturally neutral. The RTT has been developed into a

computerized assessment tool, (Computerized-RTT – CRTT) by McNeil and colleagues (McNeil et al., 2008a, 2008b, McNeil 2010). The CRTT is easier to use in both clinical and research settings and decreases many sources of variability inherent in administration and scoring of the original RTT.

No single assessment tool can identify the precise mechanisms and levels of impairment, measure performance change as a result of intervention or additional impairment, or determine the precise differential diagnosis. One strategy that has proven valid and efficient in test development for achieving these goals in countries with developing disciplines is to use existing tools that have been developed in other languages and then translate them into the language that does not have such measures. These translations are most productive when the test: A) fills an unmet need such as those left by the CCAT, B) has been shown to be a valid and reliable tool in its native language, C) can be easily translated into the other language (e.g. Mandarin) without substantial changes that would challenge its validity and reliability characteristics, and its utility, and D) can be computerized so as to reduce variability and increase standardized scoring and administration.

Because of the paucity of standardized assessment tools available in Taiwanese speech-language pathology clinics, several unstandardized and unvalidated translations of the tests exist. None of these tests have the necessary established psychometric characteristics and none have adequate normative data for Chinese speakers. With this lack of available tests, there is no reasonable way to make informed clinical decisions using any of them. Therefore, creating an array of standardized tests is imperative in the development of the relatively new profession of speech-language pathology in Taiwan.

1.1 LITERATURE REVIEW

Language deficits and their resultant communication impairments represent the primary behavioral characteristics of aphasia. People with aphasia constitute the majority of adults with language disorders. Based on the definition of aphasia proposed by McNeil and Pratt (2000), the language deficits that are consistent with aphasia cross all language processing modalities, including language-specific input (listening and reading), and output (speaking and writing) disorders. Within this theoretical framework, the language errors produced are a product of impaired processes that support or interact with language, but are not assumed to be impairments of the linguistic representations themselves or the rules used to construct language. With this assumption, the primary goal of aphasia assessment is to identify the impairments of language processing.

Most aphasia assessment tools include subtests for auditory and reading comprehension tests, such as those within the Western Aphasia Battery (WAB; Kertesz, 1982) and the Boston Diagnostic Aphasia Examination (BDAE; Goodglass, & Kaplan, 2000). However, these listening and reading tests have different test requirements, with stimuli and scoring systems differing even within the same tests. In the BDAE, the auditory comprehension requires identifying pictured objects by name and complex sentences comprehension. The BDAE scoring also differs across the tasks. In the WAB, the auditory comprehension test contains: 1) yes-no questions, 2) ten categories of word discrimination, and 3) following commands. The WAB uses a summary scoring system. It includes an aphasia quotient, a cortical quotient, and a language quotient (Sanders & Davis, 1978; Shewan, 1986; Shewan & Kertesz, 1980).

In 1962, DeRenzi and Vignolo published a concept paper outlining the motivation and general structure of a test for auditory comprehension in persons with aphasia (PWA) which they termed "the Token Test" (TT). The proposed stimuli in the TT were

to be composed of five different colors, two different shapes, and two different sizes. The auditory stimuli were to be composed of sentences varying in length and grammatical form and demonstrated by touching or moving the objects. The proposed test was specified only in general terms, with examples for how to construct exact commands and without precise instructions for administration or scoring performance. Additionally, normative and other psychometric data (reliability, validity, sensitivity, specificity, etc.) were not provided in this general "concept" paper. Following this publication, and because of the lack of stimulus, administration, scoring and psychometric development, many different versions of the test were published, but all under the title of "The Token Test". Most of these "token tests" were never adequately developed, standardized or made available for common use.

Because of this lack of consistency across the research and clinical communities, McNeil and Prescott (1978) developed what they termed "The Revised Token Test" (RTT). Their goal was to design, standardize and make available for research and clinical use a well-designed and standardized test. The RTT is an assessment tool for auditory processing and comprehension that is appropriate for administration across the lifespan from about age 5 through geriatric populations. The RTT is composed of 10 subtests, and each subtest includes 10 equally difficult commands. Following the original suggestions of DeRenzi and Vignolo (1962), the commands were structured around the systematic manipulation of objects composed of five colors, two shapes, and two sizes. Because the vocabulary of the commands (colors, shapes, and sizes) is common and universal, it can avoid or minimize the potential linguistic biases that accompany age, gender, intellectual, and cultural status. Subtests 1 to subtest 10 systematically vary in number of critical lexical items to be comprehended and/or syntactic form. The subtests have four command lengths and four sentence types. The design gives the clinicians information about lexical-semantic and syntactic levels of processing and comprehension. Clinicians can also make inferences about information

concerning client's auditory memory, auditory attention, and temporal processing from differential performance across the 10 subtests (McNeil & Prescott, 1978).

The RTT employs a 15-point multidimensional scoring system. Each element and sentence receives a score from 1 to 15. For example, in the subtest 1, each of the ten commands includes three linguistic elements: a verb, an adjective and a noun (e.g., "Touch the red circle) the definite article does not receive a score. With the designated and standardized scoring system, each command receives three separate scores from the 15 point multidimensional scoring system and each linguistic element can potentially receive three different scores (McNeil & Prescott, 1978).

The score reflects how the task was performed as well as reflecting a relative severity of impairment (McNeil, Dionigi, Langlois & Prescott, 1989). For example, a score of 15 means that the clients response was accurate and efficient. A score of 14 means that the patient vocally or subvocally rehearsed the command but completed the task without delay and without error. A score of 13 means that the response (or a component of the response) was completed with extra processing time, but was otherwise correct. A score of 12 means that the first token in a two-part command was touched before the command was finished being delivered. A score of 11 indicates that the response was self-corrected following an incorrect response. A score of 10 indicates that the patient reversed two lexical elements in a two-part command ("touch the red circle and the blue square" yielded a response of touching the "blue" circle and "red" square); in which case, only the color adjectives would receive a score of 10. A score of 9 indicates that the same stimulus (command) was delivered again because 1) no response was completed within 30 seconds; 2) the respondent moved the token instead of touching it as 3) the respondent asked for a repeat. A score of 8 represents a cue, and means that extra information is required to give a response following a repeat of the command. A score of 7 occurs when the patient makes an error in one or more units of the command, such as touching a "red" token for a "black" one or touching a "circle"

for a "square". For example, when the command is "to touch the red circle", but the patient responds by touching "the green circle", then the units "touch " and "circle" are scored 15 for an accurate response, but the unit "green" would be scored as a "7" (an error). A score of 6 indicates that the respondent perseverated on an incorrect response from the immediately previous response. For example, if the previous command "to touch the blue circle" was erred by touching the black color and it is followed by the command to "touch the green circle" and the participant continues to touch the black circle. In this situation, the color is scored as a 6. A score of 5 shows the respondent provided an intelligible response but one that was not clearly an answer to the command; or the patient rejects the command. A score of 4 reflects an unintelligible response following a repeated or cued command. A score of 3 is an unintelligible preservation. A 2 indicates an omission of the response of one unit in a two-part command. At the lowest end of the scale, a score of 1 describes "no response" (McNeil & Prescott, 1978).

A good assessment tool needs to have well established psychometric characteristics as well as clear and reliable instructions for administration and scoring. The RTT has established construct, concurrent, and content validities as well as established test-retest, inter- and intra- judge reliabilities (McNeil & Prescott, 1978). Arvedson, McNeil, and West (1986) designed a shortened version of the RTT. The shortened version included the first five items in each of nine of the ten subtests and all ten items from subtest nine. Their study showed the first five items of each subtest (save for subtest nine) correlated highly with the standard version. The correlation ranged from 0.83 to 0.94. The linguistic units in the five-item version correlated with the standard version between 0.75 and 0.98. The reliability of the fifty-five item version has been shown to be high (Park, McNeil & Tompkins, 2000).

Concurrent validity is typically assessed by the comparison of the experimental measure with a measure whose psychometric properties have been well established and

that is believed to measure the same construct as the experimental measure (Schiavetti & Metz, 2006). The RTT was originally compared with the PICA. It was demonstrated that the overall PICA score correlated moderately highly with the overall of RTT (r=0.67). The RTT correlated best with the auditory comprehension subtests of PICA (r=0.69~0.70) (McNeil & Prescott, 1978). The RTT has also been found to correlate highly with the Burden of Stroke Scale (BOSS) as well as the BDAE rating scale (Doyle, McNeil, Hula, & Mikolic 2003).

The employment of the multidimensional scoring system has posed a challenge for the time required for clinicians learning to accurately score the test on-line, for the reliability of its use, and for the computations required post-testing to summarize the scores and convert them into usable summary scores with reference to appropriate normative samples. While simpler scoring systems have been advocated (Odekar & Hallowell, 2005), simpler scoring conventions cannot provide the detailed information about the results such as the types of errors produced. For this reason, multidimensional scoring is difficult to replace (Porch, 2007). In order to reduce those burdens of administration, scoring and summarizing, the Computerized Revised Token Test (CRTT) has been developed (McNeil, 2009). The CRTT uses the same stimuli, administration procedures, tasks and scoring as the RTT. The primary difference between the RTT and the CRTT is that the computerized version provides the auditory commands via well controlled digital sound files and the participants manipulate the objects on the computer screen (either with a touchscreen or with a mouse) instead of the three-dimensional plastic objects. The scoring system employs the same rules and algorithms as the RTT but the computer scores, on-line, the responses. The computer scoring, therefore, offers precise timing of stimulus delivery as well as precise timing of all components of the response, and ultimately more reliable and more valid information from the test (McNeil et al., 2008a, 2008b).

The acoustic characteristics of the digitized speech have been shown to affect test performance in persons with aphasia. Different speech rates and stress patterns have been shown to affect auditory comprehension performance in persons with aphasia. A slow speech rate or exaggerated stress has been shown to facilitate, or impair auditory comprehension (Brookshire & Nicholas, 1984; Kimelman; 1999, 1991; Kimelman & McNeil; 1987, 1989; Nicholas & Brookshire, 1986; Pashek & Brookshire, 1982). An investigation using the CRTT showed an effect of time and frequency alterations (compression and expansion), on performance in young normal individuals (Eberwein et al., 2007).

According to Tseng (2007), the average Chinese speech rate in reading aloud ranged from 165ms per syllable to 271ms/syllable yielding a speech rate from 3.7 to 6.0 syllables per second for Mandarin Chinese. Differences were found between genders and speaking tasks. The speech rate of the female speaker in this investigation was slower than the speech rate of the single male used for comparison for each of the two reading tasks in this study. In a poem reading task, the speech rate of the female was 271 ms/syllable, and the speech rate of the male was 202ms/syllable. In a weather forecast reading task, the speech rate of the female speaker (193 ms/syllable) was again faster than the male (165 ms/syllable).

A study by Yuan, Liberman, and Cieri, (2006) showed that the average conversational speech rate in Mandarin Chinese was between 228 and 247 characters per minute, which means the Chinese speech rate in that study was from 3.8 syllables per second to 4.1 syllables per second. The speech rate for females was also slower than for males in this study. There were two syllable structures in the study: open (consonant-vowel) and closed (consonant-vowel-consonant) syllables. Most of the syllables were of the CV-structure which is consistent with the linguistic characteristics of Mandarin Chinese. In the proposed study, syllables (i.e. characters) were used for calculating the speech rate for Mandarin Chinese. In Cantonese, the preferred speech

rate is 4.3 syllables (i.e. characters) per second. The same study showed that the preferred speech rate was slower as subjects' age increased. Provided with stimuli differing in speech rate and asked to score its comprehensibility on a 9-point scale, a younger group (mean age: 25.7) preferred a speech rate of 5.4 syllables per second. The preferred speech rate of the middle age group (mean age: 44.9) was 4.3 syllables per second, and the preferred speech rate of the older group (mean age: 65.7) was 3.6 syllables per second (Chan & Lee, 2005).

Administration of the CRTT requires the manipulations of the objects on screen. In order to minimize the difficulty of accessing the tokens on the screen, the initial experimental work on the CRTT used a touchscreen. This access method has been demonstrated to be both valid (McNeil et al., 2008a) and reliable (McNeil et al., 2008b). However, there are pragmatic reasons to consider using a mouse to access the tokens on the screen; including its more universal availability and the greater potential for the development of the CRTT as a Telehealth tool with the mouse as opposed to the touchscreen. In one study using young normal adults, Heilman, McNeil, Hill and Pratt (2008) demonstrated that the touch screen access method yielded significantly higher overall scores than the mouse access method. Additional research is currently being conducted with older normal participants, with older persons with aphasia under right and left had use of the mouse and the touchscreen to determine if these findings on young normal adults are generalizable to other normal and impaired populations.

The proposed research investigated the concurrent validity of the CRTT by comparing performance for persons with aphasia on the CRTT to their performance on the Concise Chinese Aphasia Test (CCAT). This is the only standardized Mandarin Chinese aphasia assessment tool in Taiwan.

The Concise Chinese Aphasia Test was modeled after the Porch Index of Communicative Ability (PICA; Porch 1967), with some minor modifications for linguistic and cultural appropriateness. The CCAT uses the multidimensional scoring

system designed for the PICA, but has reduced it from a sixteen-point to a twelve-point system. For example, a score of 12 means that the clients responded accurately and efficiently in a time less than five seconds. A score of 11 means that the patient responded to the command correctly in five seconds but demonstrated a self-correction, dysarthria or dysfluency. A score of 10 means that the response was completed with extra processing time (over five seconds), but was otherwise correct. A score of 9 means that in five seconds, the answer was more or less correct but incomplete. If the answer is similarly incomplete but more or less correct but the client takes longer than 5 seconds, a score of 8 is assigned. A score of 7 indicates that a repeat is given and the response is like the response of score 8. A score of 6 occurs when a cue is given and the response achieves the score 8. A score of 5 is given when the repeat and the cue are given and the response is incorrect but related to the correct answer. A score of 4 means the response is incorrect after a repeat and cue is given. A score of 3 means the response can be identified but is not a related answer; for example, preservation of automatic speech such as a social convention. A score of 2 means that the response cannot be identified and has no meaning such as producing a sign or unidentified sound. A score of 1 means there was no response (Zhong, Li, & Zhang, 2002).

The subtests in the CCAT include: biographical data, oral picture description, picture-to-object matching, auditory sentence comprehension, confrontation naming, reading comprehension, sentence repetition, copying written figures, writing simple phrases and dictation. Test stimuli are common, everyday objects used across subtests, and identical to those used in the PICA. Content validity, criterion-related validity, alternate-form reliability, test-retest reliability, inter-rater reliability, intra-rater reliability, and normative data are all reported in the CCAT manual. As such, the CCAT is one of the most well developed diagnostic tools for language impairment in Taiwan (Zhong, Li, & Zhang, 2003).

Despite its strengths, the CCAT does have its limitations. It is a "traditional" aphasia test whose purpose is to provide clinicians with an overall index of language performance across modalities. The CCAT does not provide detailed or in-depth information about the nature of auditory comprehension deficits. Its single subtest of auditory sentence comprehension is composed of ten commands ordered with respect to length and complexity. Unlike the PICA, stimulus sentences often differ by more than one component (length, syntactic complexity, object name versus function), so it is difficult, if not impossible, to infer some underlying process leading to observed incorrect or inappropriate responses because of the limited number of items that are used to sample that specific behaviors. It provides limited detailed characteristics of patients' language to help clinicians to design appropriate treatment plans. Furthermore, the CCAT may not be sensitive in detecting mild sentence comprehension deficits. In such cases, clinicians and researchers must turn to other, more sensitive tools for assessing sentence processing and comprehension deficits.

Answers to the following research questions were sought:

1. Is there a significant difference in the CRTT-Mandarin Chinese overall and subtest scores between normal participants and participants with aphasia?
2. Are there significant ($p < .05$) and high ($r > .70$) correlation coefficients between the CRTT-Mandarin Chinese overall and subtest scores and each of the CCAT subtest and overall scores for the normal participants and for the participants with aphasia?

2.0 METHOD

2.1 PARTICIPANTS

Participants were 11 persons with aphasia, and 19 normal Mandarin speakers from Taiwan. Each of the normal participants was between 41 and 68 years of age (mean= 50.58, SD= 7.7) and without self-reported history of neurological disease. The participants with aphasia were between 40 and 80 years of age (mean= 50.45, SD=12), with known premorbid fluency in Mandarin Chinese and elementary school education or higher (as reported by the individual or caretaker). All participants had a medical diagnosis of left-hemisphere cerebral infarct, and a diagnosis of aphasia from a qualified speech-language pathologist. Exclusionary criteria included: (1) a self-reported premorbid history of speech, language, hearing or learning disorders, (2) a concurrent medical diagnosis of cognitive or psychiatric disorders documented in the participants' medical record or by self-reported survey, (3) known uncorrected hearing or visual deficit, by a self-reported survey.

2.2 MATARIALS

Each participant completed a self-reported survey (see appendix A). The survey documented in years each participant's age, their hand dominance, past medical history for stroke and cognitive/ psychiatric illness, speech, language, hearing, and learning

disorders history. Participants also completed a bilingual language history. All participants that spoke more than one language spoke their first language before attending school and none studied abroad. The participants completed the CRTT and the CCAT within 10 days of one another. The CCAT is available in two versions; the principal (or "A" version) was used exclusively for the current research project. Participants completed the CRTT using the mouse access method with their left hand. Equipment included a standard mouse (Logitech, M-BJ79), a laptop computer with 15.4"-diagonal widescreen (Compaq, C771US). The commands were delivered to the participant through 2 portable speakers (Logitech S120 2.0 Multimedia Speakers) placed 18 inches in front of the participant at 45 degree azimuth and delivered at 75 dB SPL as measured by a portable sound level meter, placed at the ear and matched to the calibration tone recorded within the CRTT-Mandarin program.

2.3 ACOUSTIC STIMULI

Before the recording the CRTT-Mandarin commands, the Chinese translation was read by 10 native Mandarin speakers. If two or more judges disagreed on any word in the translation, the translation was changed and judgments were again made until 9 or more of the ten judges agreed on all words (see appendix B). The acoustic stimuli were then recorded by a male native Mandarin Chinese speaker using this validated translation. The speech rate was controlled so that all sentences were between 3.5 and 4.0 syllables per second. The recording was accomplished in a sound attenuated IAC booth. After the stimuli are recorded, the CRTT-Mandarin was listened to by 10 native Mandarin speakers to note articulation or prosodic speech production errors. If errors were noted by more than two listeners, that stimulus was re-record and the process was

continued until each stimulus was judged to be free from speech production errors by 9 or more of the ten judges (see appendix B).

2.4 PROCEDURES

The participants completed the survey and the CRTT-Mandarin using the mouse access method. They sat in a quiet clinical room during all CRTT-Mandarin and CCAT data collection. The order of presentation for the CCAT and CRTT-Mandarin, were randomly assigned for each participant and all participants received both tests. The CCAT took approximately 30 minutes to administer on average (Zhong, et al., 2002). The CRTT-Mandarin took from 25 to 40 minutes to administer.

Participants completed the CRTT-Mandarin pretest before starting the CRTT-Mandarin. The pretest ensured that the participants' hearing, vision, motor skills and knowledge of the linguistic stimuli were adequate to complete the CRTT-Mandarin. If a participant was unable to complete the pretest, testing would be aborted and no further data would be collected on that individual. The auditory stimuli were presented from a loud speaker and the participants were asked to response to the commands. Participants used their left hand with the mouse. The responses and scores were recorded by the computer program online. Upon the completion of the CRTT-Mandarin, those participants who did not first undertake the CCAT were scheduled to complete it as soon as possible, but not longer than ten days. Each response was scored using the 12-point multidimensional scoring system. The experimenter administered and scored the CCAT.

2.5 DATA ANALYSIS

Data were categorized according to overall and subtest scores, for both the CRTT-Mandarin and the CCAT. The Mann-Whitney U test was computed to determine significant ($p \leqq 0.05$) differences between normal and participants

A Spearman rank-correlation coefficient was computed to determine significant ($p \leqq 0.05$) and high ($r > 0.7$) correlation coefficients in both overall and subtest scores derived from the CRTT-Mandarin and the CCAT in both the normal group and the group with aphasia.

3.0 RESULTS

3.1 VALIDATION OF MANDARIN TRANSLATION

The CRTT-Mandarin was translated from the original CRTT. All stimuli were recorded by a male native speaker of Mandarin Chinese. After Chinese who judged if the stimuli were recorded without error in articulation and syntax. From a total of 205 auditory stimuli, 41 achieved 90% agreement and 164 achieved 100% agreement. Overall judges agreed on 98% of stimuli.

3.2 GROUP DIFFERENCE

Thirty participants were administered the CRTT-Mandarin and the CCAT. Eleven males and 8 females were recruited for the normal group. They ranged in age from 41 to 68 years (mean = 50.58, SD=7.7). There were 9 males and 2 females in the group with aphasia (PWA). The PWA ranged in age from 40 to 80 years (mean=50.45, SD=12.0). The demographic data for the normal group is shown in Table 1 and in Table 2 for the PWA.

Due to experimenter error, three control participants (N6, N8, and N15) and five PWA (A6, A7, A8, A9, and A11) were not administered the pretest. However their performance indicated that they would have met the pretest requirement if the pretest had been administered. Summarized in Tables 3 and 4 are each normal participant's overall and subtest average scores and overall and subtests average efficiency scores on

the CRTT-Mandarin. Tables 5 and 6 summarize these scores for the PWA. The CRTT-Mandarin overall scores ranged from 9.16 to 11.78 (mean = 10.23, SD=.89) for the PWA, and from 12.84 to 14.23 (Mean = 13.54; SD =.59) for the normal group. The CRTT-Mandarin efficiency scores ranged for the normal group from 9.93 to 12.52 (mean = 11.29, SD=1.06). The efficiency score for the PWA ranged from 5.88 to 9.23 (mean = 7.19, SD=1.19). The ranges of scores for both metrics for the two groups did not overlap. Table 7 summarizes the overall and subtests CRTT-Mandarin and the overall and subtest CRTT-Mandarin efficiency scores for both groups. Figure 1 represents the scores for the CRTT-Mandarin for the PWA group and the normal group. Figure 2 represents the CRTT -Mandarin efficiency scores for both groups.

The overall score for the CCAT ranged from 11.89 to 12.00 for the normal group (mean = 11.97, SD=.04), and from 5.88 to 9.23 for the PWA (mean = 9.10, SD=1.12). Table 4 summarizes the subtest and overall CCAT scores for both groups. Figure 3 represented these scores for the CCAT for both groups.

Table 8 presents each normal individual participants overall and subtest performance on the CCAT. Table 9 presents these same data for the PWA. Table 10 summarizes the overall and subtest averages for both groups. Summarized in Tables 11, 12 and 13 are the median scores for both groups, for each CRTT-Mandarin subtest and overall and the CRTT-Mandarin efficiency subtest and overall and the CCAT subtests and overall respectively. Also summarized on these tables are the nonparametric Mann-Whitney U values, the two-tailed asymptotic significant values and the calculated effective sizes. The Mann-Whitney U values in these tables express the number of participants in the PWA group whose scores for that particular comparison was higher than any participant's score in the normal group. A value of zero signifies that no PWA scored higher than any normal participant for that comparison. The groups differed significantly ($p<.05$) on the CRTT-Mandarin and the CRTT-Mandarin efficiency and the CCAT overall mean scores and all subtests mean

scores. The significant differences between groups for each contrast along with the large effects sizes (r) illustrates large and reliable differences between groups on all measures with the single exception of the picture to object matching subtest on the CCAT. This subtest yielded ceiling scores for both participants groups. That is, the Picture-to-Object matching subtest of the CCAT was not significantly (p>0.05) different between the PWA and the normal group.

Table 1 Demographic data for the normal participants

Participants	Sex	Age(yrs)	Education completed	language
N1	F	50	college	M,H,T
N2	M	54	college	M
N3	M	45	high school	M,T
N4	F	42	high school	M,T
N5	F	50	college	M,T
N6	F	49	high school	M,T
N7	F	57	college	M
N8	M	60	college	M
N9	M	68	college	M
N10	F	63	high school	M
N11	M	46	high school	M,H
N12	M	48	graduate school	M,H
N13	M	42	college	M,H
N14	M	55	high school	M
N15	M	57	middle school	M,T
N16	F	41	college	M
N17	M	46	graduate school	M,T
N18	F	42	college	M,T
N19	M	46	college	M,T
Mean	11M;	50.58		M=7 ; M,T=8
SD		7.7		M,H=3; M,H,T =3

M: Mandarin; T: Taiwanese; H: Hakka (one of languages that people speak in Taiwan)

Table 2 Demographic data for of the PWA

Particip	S	Age(y	Education	language
A1	M	50	high school	M,T
A2	M	41	college	M,T
A3	M	40	college	M
A4	F	41	college	M.T
A5	M	42	high school	MT
A6	M	80	college	M,T,J
A7	M	51	high school	M,T
A8	F	45	college	M
A9	M	48	college	M
A10	M	54	college	M
A11	M	63	graduate school	M,T
Mean	9	50.45	M=4; M,T=6	
SD		12.0	M,T,J=1	

M: Mandarin; T: Taiwanese; J: Japanese

Table 3 Normal participants' performance on the CRTT-Mandarin

Participants	Gender	Age	Subtests										
			I	II	III	IV	V	VI	VII	VIII	IX	X	Overall-mean
N1	F	50	14.00	13.30	13.80	14.18	13.20	12.90	13.50	13.50	14.80	14.00	13.69
N2	M	54	14.60	14.40	14.07	14.53	13.80	13.72	14.10	14.00	15.00	15.00	14.27
N3	M	45	13.60	14.60	14.70	13.95	12.80	13.82	13.70	14.10	13.70	14.00	13.87
N4	F	42	13.60	13.80	14.70	14.57	12.35	14.22	12.93	12.90	14.25	15.00	13.79
N5	F	50	13.20	13.00	14.05	13.82	12.65	12.83	12.60	12.00	14.30	13.00	13.19
N6	F	49	13.00	13.00	12.70	14.38	12.07	12.64	12.35	12.80	15.00	15.00	13.24
N7	F	57	13.00	13.00	12.40	12.82	12.10	11.54	12.90	12.50	13.40	12.00	12.60
N8	M	60	13.80	13.20	13.77	14.10	12.10	11.93	12.33	13.20	12.57	11.00	12.81
N9	M	68	13.20	12.65	14.20	13.72	12.18	12.35	12.93	12.90	15.00	15.00	13.37
N10	F	63	13.08	14.05	13.20	13.55	12.93	12.68	12.77	12.30	14.33	15.00	13.35
N11	M	46	13.00	13.00	13.00	12.96	13.27	13.25	12.77	13.50	15.00	14.00	13.34
N12	M	48	14.40	14.80	14.20	14.30	13.50	14.32	14.27	14.70	14.80	14.00	14.33
N13	M	42	13.00	13.00	13.10	14.13	13.00	14.10	12.22	14.20	14.30	14.00	13.49
N14	M	55	13.00	12.70	14.10	13.72	12.37	12.38	12.57	13.00	12.85	13.00	12.96
N15	M	57	12.50	13.00	12.40	11.25	12.43	11.21	12.77	12.20	13.50	13.00	12.44
N16	F	41	14.40	14.40	14.83	14.90	14.17	14.45	13.87	14.80	15.00	15.00	14.53
N17	M	46	14.80	13.70	15.00	14.90	12.32	13.40	14.23	14.00	14.20	14.00	14.08
N18	F	42	14.13	14.60	14.83	14.28	13.03	13.60	12.57	12.60	14.10	14.00	13.75
N19	M	46	14.80	14.45	14.60	14.80	13.60	13.45	14.43	14.40	14.20	13.00	14.16
Mean			13.64	13.61	13.88	13.94	12.84	13.09	13.15	13.35	14.23	13.68	13.54

Table 4 Normal participant's performance on the CRTT-Mandarin efficiency

Participants	Gender	Age	Subtests										
			I	II	III	IV	V	VI	VII	VIII	IX	X	Overall-mean
N1	F	50	13.04	11.98	11.18	11.23	9.69	9.37	10.83	9.70	13.00	12.29	11.24
N2	M	54	13.75	13.45	12.53	12.36	11.68	10.67	11.96	11.20	14.00	13.44	12.48
N3	M	45	12.54	13.53	12.72	11.36	9.83	10.68	10.52	11.00	12.00	11.90	11.60
N4	F	42	12.56	12.92	12.70	12.42	9.67	11.92	10.91	10.50	13.00	13.26	12.00
N5	F	50	11.93	11.40	11.75	11.31	9.72	9.50	10.01	8.50	12.00	11.77	10.81
N6	F	49	11.58	11.48	10.81	11.74	8.75	9.58	9.58	9.20	14.00	12.95	10.92
N7	F	57	10.90	10.97	10.01	9.91	7.41	6.20	8.78	6.50	11.00	9.94	9.18
N8	M	60	12.70	11.43	11.58	11.69	9.31	7.78	9.16	9.90	11.00	9.45	10.36
N9	M	68	11.99	11.13	11.87	11.33	8.85	9.63	10.34	10.30	14.00	13.37	11.25
N10	F	63	12.10	12.32	11.35	11.19	10.56	10.19	10.17	8.90	11.00	11.33	10.93
N11	M	46	11.46	11.11	10.73	10.35	10.22	9.63	9.75	10.60	13.00	11.42	10.87
N12	M	48	13.47	13.84	12.55	12.04	10.98	11.79	11.74	12.00	13.00	13.27	12.51
N13	M	42	10.81	11.12	10.54	11.14	10.41	11.13	9.52	11.40	13.00	12.23	11.09
N14	M	55	11.68	11.21	12.08	10.99	9.22	9.29	9.48	9.80	11.00	10.89	10.53
N15	M	57	10.21	10.75	9.30	8.26	8.73	6.58	9.12	7.70	11.00	10.41	9.19
N16	F	41	13.47	13.42	13.26	13.11	12.06	12.11	11.98	12.80	14.00	13.48	12.98
N17	M	46	13.96	12.92	13.31	12.80	9.45	10.50	12.10	11.20	13.00	13.02	12.20
N18	F	42	12.99	13.60	13.27	12.63	10.70	11.27	9.24	9.20	13.00	12.57	11.84
N19	M	46	14.08	13.46	12.98	12.51	11.53	10.89	12.85	12.90	13.00	11.45	12.55
Mean			12.38	12.21	11.82	11.49	9.94	9.93	10.42	10.17	12.52	12.02	11.29

Table 5 PWA's performance on the CRTT-Mandarin

Participants	Gender	Age	Subtests										
			I	II	III	IV	V	VI	VII	VIII	IX	X	Overall-mean
A1	M	50	10.57	10.45	9.22	9.69	9.57	9.95	10.02	9.70	12.29	12.00	10.37
A2	M	41	10.63	10.70	9.10	11.11	10.35	11.10	10.12	9.80	11.13	10.00	10.38
A3	M	40	12.60	12.10	10.87	10.93	10.77	9.94	10.73	11.30	10.03	12.00	11.13
A4	F	41	12.80	11.57	7.97	9.79	10.13	7.83	10.23	8.00	12.38	11.00	10.20
A5	M	42	12.75	12.44	11.85	9.69	11.77	11.49	10.98	11.30	13.13	13.00	11.86
A6	M	80	12.00	10.57	6.33	6.13	8.68	7.56	10.02	9.40	9.07	11.00	9.07
A7	M	51	11.63	10.68	8.85	7.75	9.86	10.70	10.32	9.50	10.43	11.00	10.05
A8	F	45	11.33	9.93	6.48	6.85	7.58	7.71	9.70	9.20	11.75	12.00	9.22
A9	M	48	12.93	11.20	10.50	9.50	10.73	10.43	10.35	10.70	11.22	10.00	10.77
A10	M	54	10.77	10.82	10.92	11.01	9.92	10.25	9.69	10.30	10.57	11.00	10.50
A11	M	63	11.56	9.68	9.08	8.28	8.60	8.69	6.58	8.10	7.88	11.00	8.97
Mean			11.78	10.92	9.20	9.16	9.81	9.60	9.89	9.75	10.90	11.30	10.23

Table 6 PWA performance on the CRTT-Mandarin efficiency

Participants	Gender	Age	Subtests										
			I	II	III	IV	V	VI	VII	VIII	IX	X	Overall-mean
A1	M	50	8.31	9.31	11.08	10.14	10.75	8.93	8.88	6.09	11.34	8.33	8.39
A2	M	41	7.26	9.52	9.93	7.87	8.50	7.21	7.64	7.58	9.49	7.53	6.71
A3	M	40	7.16	6.48	8.28	6.21	9.16	5.26	5.23	4.30	8.63	7.76	5.35
A4	F	41	6.93	8.71	9.10	6.46	7.33	4.61	5.79	4.88	7.20	8.00	5.63
A5	M	42	5.22	8.39	6.50	4.25	8.83	4.37	4.39	4.41	8.54	5.47	5.72
A6	M	80	5.38	7.99	6.95	3.66	7.37	4.64	5.40	4.50	7.07	5.81	7.12
A7	M	51	6.03	8.00	7.09	4.27	6.78	3.76	6.00	4.80	8.41	5.96	5.44
A8	F	45	5.50	7.60	7.80	4.00	8.10	5.20	4.60	3.10	6.90	7.20	4.50
A9	M	48	9.00	9.00	7.00	9.00	11.00	7.00	7.00	8.00	9.00	8.00	7.00
A10	M	54	9.86	9.85	9.81	8.17	11.11	6.77	7.58	9.17	7.56	8.26	7.50
A11	M	63	7.05	8.54	8.39	6.45	8.93	5.75	6.29	5.72	8.43	7.27	6.35
Mean			9.23	8.11	6.71	6.79	6.01	5.99	6.01	5.88	8.51	8.70	7.19

Table 7 Means of CRTT-Mandarin and CRTT-Mandarin efficiency

Subtests	Aphasia		Normal	
	CRTT	CRTT-e	CRTT	CRTT-e
I	11.78	9.23	13.64	12.38
II	10.92	8.11	13.61	12.21
III	9.20	6.71	13.88	11.82
IV	9.16	6.79	13.94	11.49
V	9.81	6.01	12.84	9.94
VI	9.60	5.99	13.09	9.93
VII	9.89	6.01	13.15	10.42
VIII	9.75	5.88	13.35	10.17
IX	10.90	8.51	14.23	12.52
X	11.30	8.695	13.68	12.02
Overall-mean	10.23	7.19	13.54	11.29
SD	.89	1.19	.59	1.06

CRTT-e: CRTT-Mandarin efficiency score

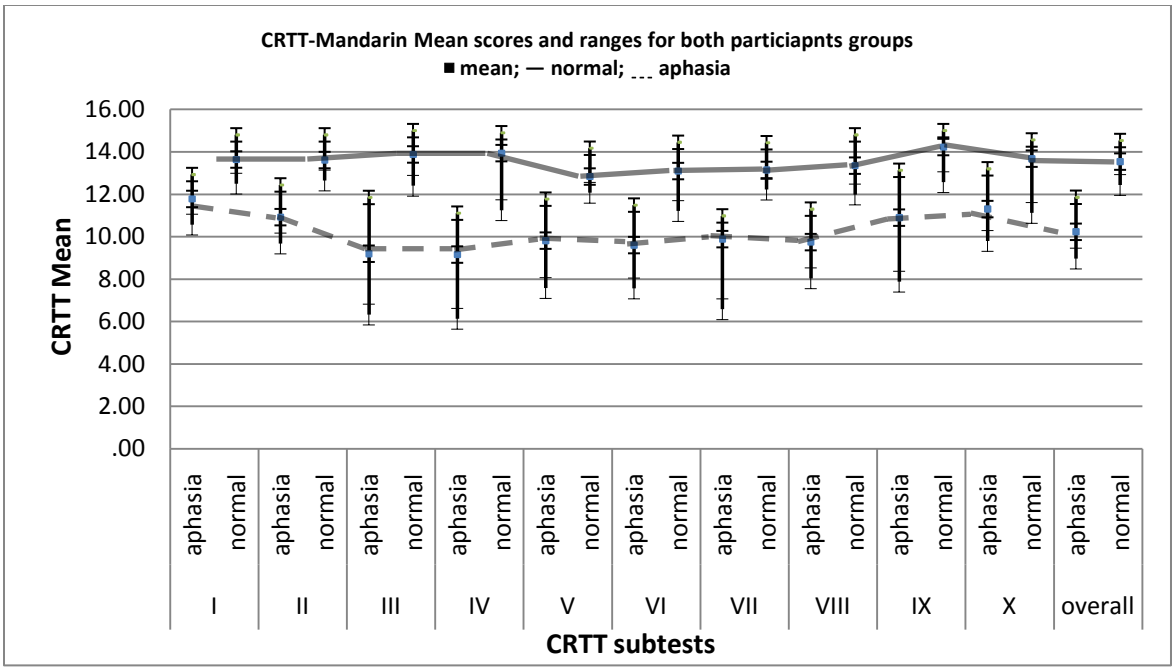

Figure 1 Mean scores for CRTT-Mandarin subtests and overall average scores. Error bar indicate +/- 3 standard deviations.

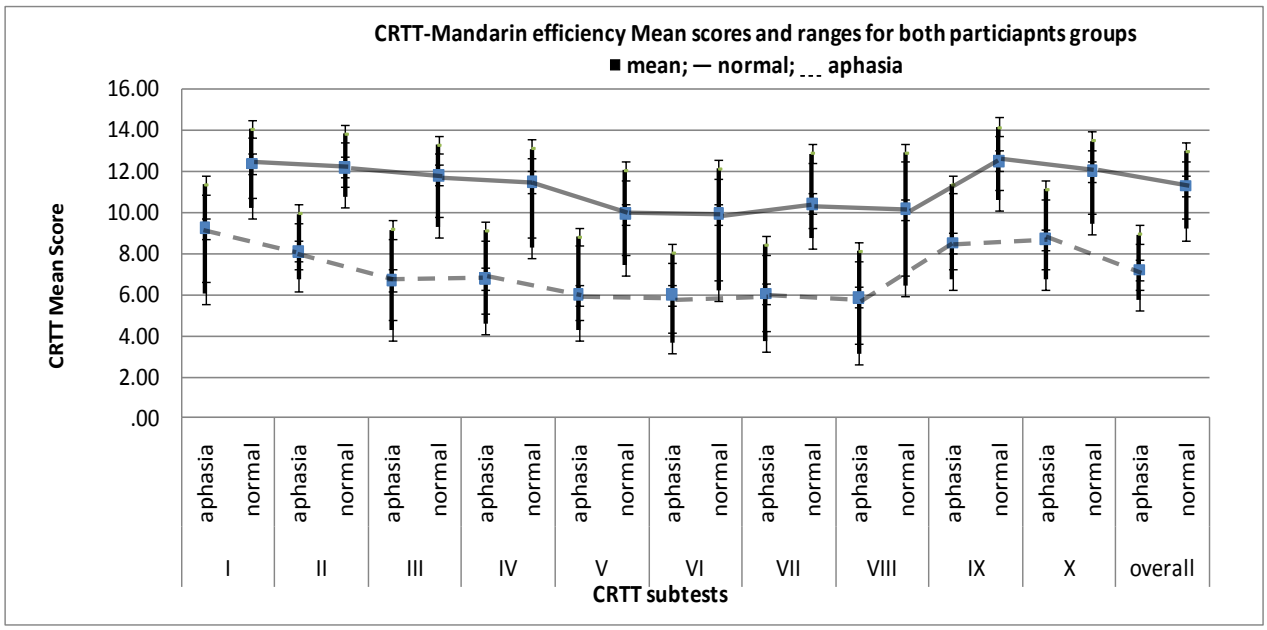

Figure2 Mean scores for CRTT-Mandarin efficiency subtests and overall average scores. Error bar indicate +/- 3 standard deviations.

Table 8 Normal participants' performance on CCAT

Participants	Gender	Age	Subtests									
			Simple questions	Oral picture description	Picture-to-object matching	Auditory sentence comprehension	Confrontation naming	Reading comprehension	Sentence repetition	Copying written figures	Writing simple phrases and dictation	Overall-mean
N1	F	50	12.00	11.90	12.00	12.00	12.00	12.00	12.00	12.00	12.00	11.99
N2	M	54	12.00	12.00	12.00	11.90	12.00	12.00	12.00	12.00	12.00	11.99
N3	M	45	12.00	12.00	12.00	12.00	12.00	11.60	12.00	12.00	12.00	11.96
N4	F	42	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
N5	F	50	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
N6	F	49	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
N7	F	57	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
N8	M	60	12.00	12.00	12.00	11.70	12.00	12.00	12.00	12.00	12.00	11.97
N9	M	68	12.00	12.00	12.00	11.90	12.00	12.00	12.00	12.00	12.00	11.99
N10	F	63	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
N11	M	46	12.00	11.50	12.00	12.00	12.00	12.00	12.00	12.00	12.00	11.94
N12	M	48	12.00	11.90	12.00	12.00	12.00	12.00	12.00	12.00	12.00	11.99
N13	M	42	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
N14	M	55	12.00	12.00	12.00	11.50	12.00	11.50	12.00	12.00	12.00	11.89
N15	M	57	11.60	12.00	12.00	11.00	12.00	12.00	12.00	12.00	12.00	11.84
N16	F	41	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
N17	M	46	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
N18	F	42	12.00	12.00	12.00	11.90	12.00	12.00	12.00	12.00	12.00	11.99
N19	M	46	11.70	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	11.97
Mean			11.96	11.96	12.00	11.89	12.00	11.95	12.00	12.00	12.00	11.97

Table 9 PWA's performance on CCAT

Participants	Gender	Age	Subtests									
			Simple questions	Oral picture description	Picture-to-object matching	Auditory sentence comprehension	Confrontation naming	Reading comprehension	Sentence repetition	Copying written figures	Writing simple phrases and dictation	Overall-mean
A1	M	50	8.20	4.20	12.00	8.00	7.70	7.60	8.00	9.00	7.00	7.97
A2	M	41	10.20	3.50	12.00	7.40	4.60	9.70	5.00	11.00	3.80	7.44
A3	M	40	9.30	7.50	12.00	10.00	10.30	11.20	10.00	11.00	7.30	9.84
A4	F	41	11.40	7.30	12.00	11.50	12.00	10.70	11.90	12.00	7.20	10.67
A5	M	42	10.90	10.70	12.00	9.80	10.80	11.40	10.80	9.00	4.70	10.01
A6	M	80	12.00	11.80	12.00	9.70	12.00	9.40	10.90	11.00	5.60	10.49
A7	M	51	10.40	7.10	12.00	9.50	10.20	8.50	8.80	9.00	4.50	8.89
A8	F	45	10.90	10.40	12.00	9.30	10.50	10.60	9.80	10.00	5.00	9.83
A9	M	48	8.70	5.80	12.00	7.70	5.50	9.40	7.00	9.00	5.20	7.81
A10	M	54	8.10	7.10	12.00	7.10	6.80	7.90	8.00	12.00	9.30	8.70
A11	M	63	10.10	5.50	12.00	9.00	9.20	8.60	8.40	9.00	4.50	8.48
Mean			10.02	7.35	12.00	9.00	9.05	9.55	8.96	10.18	5.83	9.10

Table 10 Means of CCAT

CCAT subtests	Aphasia	Normal
Simple questions	10.02	11.96
Oral picture description	7.35	11.96
Picture-to-object matching	12.00	12.00
Auditory sentence comprehension	9.00	11.89
Confrontation naming	9.05	12.00
Reading comprehension	9.55	11.95
Sentence repetition	8.96	12.00
Copying written figures	10.18	12.00
Writing simple phrases and dictation	5.83	12.00
Overall-mean	9.10	11.97
SD	1.12	.04

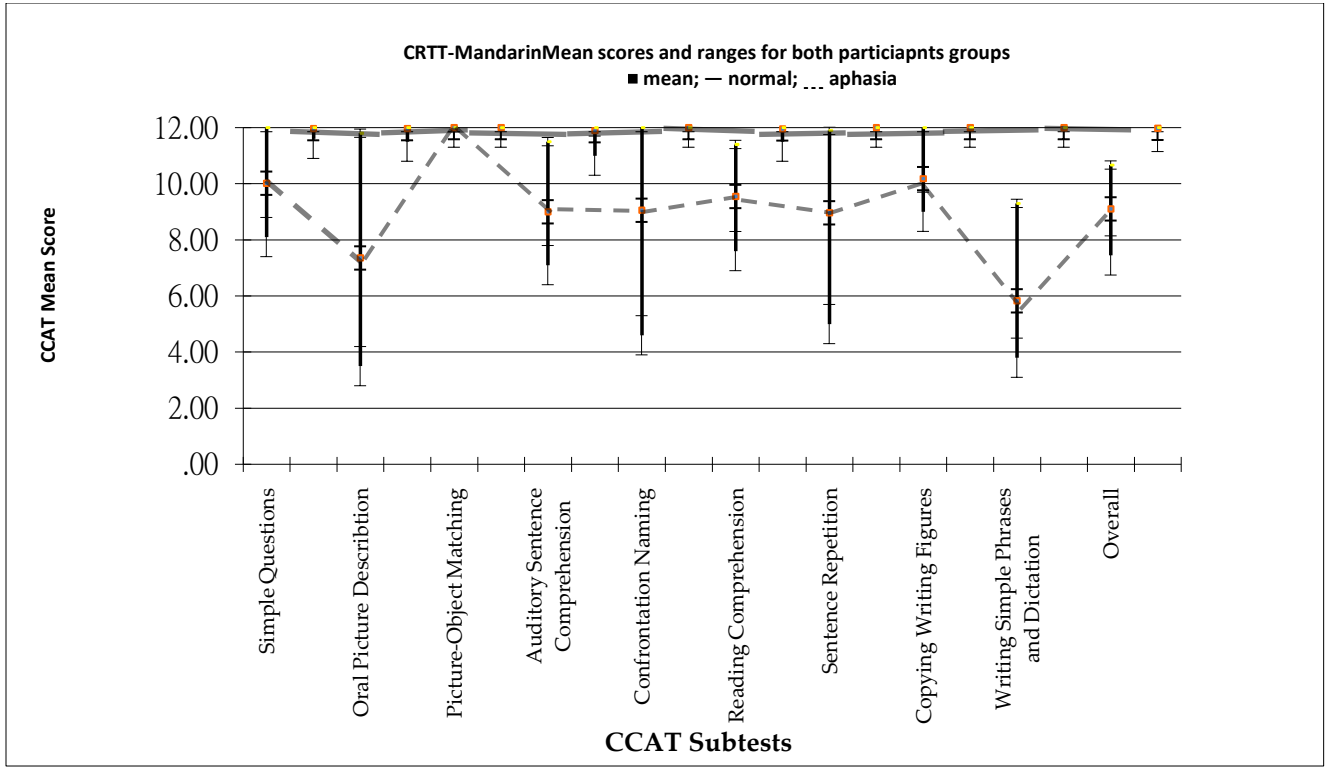

Figure 3 Mean scores for CCAT subtests and overall average scores. Error bar indicates +/- 3 standard deviations.

Table 11 Test Statistics of the CRTT-Mandarin between the PWA (N=11) and the normal group (N=19)

CRTT-Mandarin subtests and overall scores	PWA Median	Normal group Median	Mann-Whitney U	Asymp. Sig. (2-tailed)	Effect size
I	11.63	13.60	4	≤.05	-0.79
II	10.70	13.30	0	≤.05	-0.82
III	9.10	14.07	0	≤.05	-0.82
IV	9.69	14.13	0	≤.05	-0.82
V	9.92	12.80	0	≤.05	-0.82
VI	9.95	13.25	1	≤.05	-0.81
VII	10.12	12.90	0	≤.05	-0.82
VIII	9.70	13.18	0	≤.05	-0.82
IX	11.13	14.30	2	≤.05	-0.81
X	11.28	13.76	10	≤.05	-0.74
overall	10.37	13.49	0	≤.05	-0.82

Table 12 Test Statistics of the CRTT-Mandarin efficiency between PWA (N=11) and the normal group (N=19)

CRTT-Mandarin efficiency subtests and overall scores	PWA Median	Normal group Median	Mann-Whitney U	Asymp. Sig. (2-tailed)	Effect size
I	8.93	12.54	7	≤.05	-0.77
II	7.64	11.98	0	≤.05	-0.82
III	6.48	11.87	0	≤.05	-0.82
IV	6.93	11.36	2	≤.05	-0.81
V	5.47	9.72	5	≤.05	-0.78
VI	5.81	10.19	11	≤.05	-0.73
VII	6.00	10.17	0	≤.05	-0.82
VIII	5.54	10.34	7	≤.05	-0.77
IX	8.39	12.82	5	≤.05	-0.78
X	8.26	12.23	7	≤.05	-0.77
Overall	7.05	11.24	0	≤.05	-0.82

Table 13 Test Statistics of the CCAT between PWA (N=11) and the normal group (N=19)

CCAT subtests and overall scores	PWA Median	Normal group Median	Mann-Whitney U	Asymp. Sig. (2-tailed)	Effect size
Simple questions	10.20	12.00	10.5	≤.05	-0.83
Oral picture description	7.10	12.00	1	≤.05	-0.88
Picture-to-object matching	12.00	12.00	104.5	1.000	0.00
Auditory sentence comprehension	9.30	12.00	1.5	≤.05	-0.84
Confrontation naming	10.20	12.00	19	≤.05	-0.83
Reading comprehension	9.40	12.00	0	≤.05	-0.91
Sentence repetition	8.80	12.00	0	≤.05	-0.95
Copying written figures	10.00	12.00	19	≤.05	-0.83
Writing simple phrases and dictation	5.20	12.00	0	≤.05	-0.95
CCAT-overall	8.89	11.99	0	≤.05	-0.83

3.3 CORELLATIONS

The normal subjects produced the highest score possible (12.00) on several subtests of the CCAT: picture-to-object matching, confrontation naming, sentence repetition, copying written figures, and writing simple phrases and dictation. Correlations were not computed for these subtests. As summarized in Table 14 for the subtest and overall scores for the normal group and Table 15 for the subtest and overall CRTT-Mandarin efficiency scores for the normal group, there was one significant (p>.05) correlation coefficient between the CRTT-Mandarin and the CCAT for those subtests for which a ceiling effect was not shown. Correlation coefficients ranged from -.03 for the efficiency measure to the single significant correlation of 0.48 for the CRTT-Mandarin score.

The group with aphasia also produced a ceiling mean of 12.00 on the pictures-to-objects matching subtest of the CCAT, but demonstrated a range of scores well below the ceiling on all other subtests. The one significant correlation coefficient between the CRTT-Mandarin and the CCAT for the normal group occurred on subtest VI of the CRTT-Mandarin and the CCAT auditory subtest (Table14). For the PWA, only the simple questions of the CCAT correlated significantly and moderately highly with subtest III of the CRTT-Mandarin (r= -.65). Indeed as scores for the subtest III rose, corresponding CCAT scores fell. These results are summarized in Table 16. Summarized in Table 17, the confrontation naming, the sentence repetition, and the writing simple phrases and dictation of the CCAT correlated with the subtest VII of CRTT-Mandarin efficiency, and the reading comprehension of the CCAT correlated with the subtest II of CRTT-Mandarin efficiency. While some of the correlation coefficients reached significance between the CCAT and the CRTT-Mandarin, none of them reached the predetermined criterion (r=.70) (Table 14 to Table 17).

There was a very restricted range of scores for the normal participants and there were few participants with aphasia in the sample. Additionally, performance across the range of PWA and the normal participants can be conceived of as a continuum (McNeil, 1982). Therefore, the data from both groups were combined for correlation analysis. Table 18 summarizes these correlations across subtest and overall scores. All correlations reached significance ($p<0.01$) and the great majority reached the predetermined .70 level. The correlations ranged from .62 to .85. The overall of the CRTT-Mandarin correlated with the overall of the CCAT was r=.75. The CCAT and the CRTT-Mandarin efficiency correlations yielded similar values (Table 19). These correlations ranged from .57 to .83, which was slightly lower than the regular CRTT-Mandarin scores

Table 14 Correlation matrix for CRTT-Mandarin and CCAT for 19 normal participants

CCAT	CRTT-Mandarin											
	I	II	III	IV	V	VI	VII	VIII	IX	X	overall	Average
Simple questions	.045	-.030	.162	.089	-.142	.237	-.201	.056	.274	.345	.118	.121
Oral picture description	-.038	-.095	.162	.104	-.394	-.174	-.216	-.280	-.381	.063	-.137	.146
Picture-to-object matching	**	**	**	**	**	**	**	**	**	**	**	**
Auditory sentence comprehension	.168	.277	.088	.315	.196	**.480***	.317	.305	.366	.282	.384	.227
Confrontation naming	**	**	**	**	**	**	**	**	**	**	**	**
Reading comprehension	.185	.042	-.196	.208	.099	.016	.063	-.115	.416	.292	.079	.122
Sentence repetition	**	**	**	**	**	**	**	**	**	**	**	**
Copying written figures	**	**	**	**	**	**	**	**	**	**	**	**
Writing simple phrases and dictation	**	**	**	**	**	**	**	**	**	**	**	**
CCAT-overall	.109	.029	.080	.368	-.157	.255	-.023	-.091	.315	**.544***	.189	.154
Average	.109	.095	.138	.217	.198	.232	.164	.169	.169	.350	.305	.154

*. Correlation is significant at the .05 level (2-tailed).

**Correlation coefficients were not computed for these subtests because all subjects performed a ceiling effect.

Table 15 Correlation matrix for CRTT-Mandarin efficiency and CCAT for 19 normal participants

CCAT	CRTT-Mandarin efficiency											
	I	II	III	IV	V	VI	VII	VIII	IX	X	overall	Average
Simple questions	.030	.119	.118	.118	.056	.145	-.003	-.003	.230	.319	.026	.106
Oral picture description	-.062	-.021	.199	.203	-.182	-.006	-.141	-.158	-.293	-.058	-.058	.126
Picture-to-object matching	**	**	**	**	**	**	**	**	**	**	**	**
Auditory sentence comprehension	.145	.230	.079	.179	.288	.384	.454	.256	.286	.222	.324	.259
Confrontation naming	**	**	**	**	**	**	**	**	**	**	**	**
Reading comprehension	.132	-.076	-.181	.197	.135	.109	.105	-.023	.382	.227	.138	.155
Sentence repetition	**	**	**	**	**	**	**	**	**	**	**	**
Copying written figures	**	**	**	**	**	**	**	**	**	**	**	**
Writing simple phrases and dictation	**	**	**	**	**	**	**	**	**	**	**	**
CCAT-overall	.066	.076	.066	.302	.072	.287	.197	-.053	.263	.383	.191	.178
Average	.087	.104	.129	.200	.147	.186	.180	.099	.291	.242	.147	.165

*. Correlation is significant at the 0.05 level (2-tailed).

**Correlation coefficients were not computed for these subtests because all subjects performed a ceiling effect.

Table 16 Correlation matrix for CRTT-Mandarin and CCAT for 11 PWA

CCAT	CRTT-Mandarin											
	I	II	III	IV	V	VI	VII	VIII	IX	X	overall	Average
Simple questions	.369	.014	**-.651***	-.473	-.155	-.351	.160	-.487	.114	.123	-.392	.299
Oral picture description	.487	.292	-.182	-.425	.032	-.383	.260	.023	.059	.433	.018	.236
Picture-to-object matching	**	**	**	**	**	**	**	**	**	**	**	**
Auditory sentence comprehension	.600	.373	-.245	-.232	.182	-.327	.492	-.155	.127	.555	-.018	.301
Confrontation naming	.451	.141	-.428	-.447	-.128	-.538	.171	-.360	.128	.556	-.251	.327
Reading comprehension	.574	.601	.077	.137	.519	.005	.591	.205	.323	.351	.378	.342
Sentence repetition	.510	.255	-.342	-.336	-.018	-.497	.235	-.292	.100	.547	-.164	.300
Copying written figures	.019	.278	-.149	.403	.057	-.422	-.170	-.105	-.096	-.101	.024	.166
Writing simple phrases and dictation	.141	.337	.223	.269	.132	-.387	-.018	.187	.087	.323	.287	.217
CCAT-overall	.500	.327	-.282	-.264	.027	-.464	.232	-.227	.118	.500	-.091	.276
Average	.406	.291	.287	.332	.139	.375	.259	.227	.128	.388	.180	.274

*. Correlation is significant at the 0.05 level (2-tailed).

**Correlation coefficients were not computed for these subtests because all subjects performed a ceiling effect.

Table 17 Correlation matrix for CRTT-Mandarin efficiency and CCAT for 11 PWA

CCAT	CRTT-Mandarin efficiency											
	I	II	III	IV	V	VI	VII	VIII	IX	X	overall	Average
Simple questions	.109	-.050	-.483	-.556	-.442	-.355	-.560	.374	.023	-.210	-.392	.323
Oral picture description	.146	-.018	-.091	-.305	-.251	.396	-.469	.036	-.205	-.100	-.282	.209
Picture-to-object matching	**	**	**	**	**	**	**	**	**	**	**	
Auditory sentence comprehension	.364	.173	-.091	-.200	-.327	-.373	-.345	.136	-.082	-.009	-.191	.208
Confrontation naming	.055	-.178	-.292	.492	-.524	-.574	**-.679***	-.323	-.182	.137	-.442	.353
Reading comprehension	.588	**.624***	.241	.228	.264	.123	.100	.237	.369	.301	.305	.307
Sentence repetition	.150	-.096	-.205	-.378	-.487	-.528	**-.629***	-.246	-.182	-.128	-.360	.308
Copying written figures	.024	.140	-.072	.222	-.372	-.333	-.352	.000	-.048	-.043	-.048	.150
Writing simple phrases and dictation	.032	-.023	.310	.223	-.264	-.492	-.200	.096	-.182	.027	-.014	.169
CCAT-overall	.145	-.064	-.164	-.309	-.491	-.545	**-.627***	-.191	-.164	-.109	-.327	.285
Average	.179	.152	.217	.324	.380	.413	.440	.182	.160	.118	.262	.257

*. Correlation is significant at the 0.05 level (2-tailed).

**Correlation coefficients were not computed for these subtests because all subjects performed a ceiling effect.

Table 18 Correlation matrix for CRTT-Mandarin and CCAT for 19 Normal participants + 11 PWA (30 total participants)

CCAT	CRTT-Mandarin											
	I	II	III	IV	V	VI	VII	VIII	IX	X	overall	Average
Simple questions	**.734****	**.697****	**.672****	**.670****	**.661****	**.699****	**.677****	**.680****	**.726****	**.705****	**.685****	.691
Oral picture description	**.745****	**.753****	**.769****	**.747****	**.679****	**.691****	**.727****	**.701****	**.672****	**.716****	**.727****	.721
Picture-to-object matching	***	***	***	***	***	***	***	***	***	***	***	***
Auditory sentence comprehension	**.790****	**.805****	**.726****	**.781****	**.772****	**.808****	**.815****	**.777****	**.809****	**.779****	**.805****	.788
Confrontation naming	**.736****	**.720****	**.637****	**.661****	**.686****	**.624****	**.712****	**.646****	**.701****	**.678****	**.663****	.679
Reading comprehension	**.806****	**.813****	**.746****	**.810****	**.814****	**.768****	**.813****	**.765****	**.846****	**.774****	**.803****	.796
Sentence repetition	**.811****	**.825****	**.788****	**.789****	**.806****	**.773****	**.821****	**.791****	**.803****	**.773****	**.798****	.798
Copying written figures	**.689****	**.746****	**.703****	**.761****	**.715****	**.662****	**.681****	**.685****	**.700****	**.617****	**.713****	.697
Writing simple phrases and dictation	**.789****	**.830****	**.820****	**.823****	**.815****	**.777****	**.807****	**.818****	**.797****	**.747****	**.824****	.804
CCAT-overall	**.751****	**.732****	**.712****	**.783****	**.669****	**.744****	**.712****	**.672****	**.785****	**.824****	**.747****	.739
Average	.761	.769	.730	.758	.735	.727	.752	.726	.760	.735	.752	.746

*. Correlation is significant at the 0.05 level (2-tailed) **. Correlation is significant at the 0.01 level (2-tailed).

***Correlation coefficients were not computed for these subtests because all subjects performed a ceiling effect.

Table 19 Correlation matrix for CRTT-Mandarin efficiency and CCAT for 19 Normal participants + 11 PWA (30 total participants)

CCAT	CRTT-Mandarin efficiency											
	I	II	III	IV	V	VI	VII	VIII	IX	X	overall	Average
Simple questions	**.674****	**.703****	**.685****	**.664****	**.640****	**.633****	**.650****	**.634****	**.693****	**.675****	**.670****	.666
Oral picture description	**.696****	**.747****	**.781****	**.753****	**.664****	**.633****	**.699****	**.665****	**.653****	**.683****	**.725****	.700
Picture-to-object matching	***	***	***	***	***	***	***	***	***	***	***	***
Auditory sentence comprehension	**.737****	**.782****	**.733****	**.747****	**.730****	**.724****	**.801****	**.722****	**.764****	**.745****	**.783****	.752
Confrontation naming	**.661****	**.678****	**.665****	**.625****	**.587****	**.534****	**.616****	**.602****	**.652****	**.614****	**.651****	.626
Reading comprehension	**.775****	**.793****	**.757****	**.800****	**.774****	**.715****	**.792****	**.732****	**.826****	**.781****	**.808****	.778
Sentence repetition	**.760****	**.802****	**.796****	**.769****	**.741****	**.685****	**.772****	**.739****	**.766****	**.749****	**.787****	.761
Copying written figures	**.646****	**.710****	**.708****	**.717****	**.615****	**.572****	**.660****	**.648****	**.668****	**.639****	**.704****	.662
Writing simple phrases and dictation	**.760****	**.806****	**.825****	**.804****	**.748****	**.685****	**.796****	**.761****	**.753****	**.751****	**.807****	.772
CCAT-overall	**.683****	**.721****	**.714****	**.758****	**.659****	**.677****	**.723****	**.632****	**.740****	**.763****	**.736****	.710
Average	.749	.740	.737	.684	.651	.723	.682	.724	.711	.741	.714	.749

*. Correlation is significant at the 0.05 level (2-tailed) **. Correlation is significant at the 0.01 level (2-tailed).

***Correlation coefficients were not computed for these subtests because all subjects performed a ceiling effect.

4.0 DISCUSSION

4.1 GROUP DIFERENCE

It was predicted that there would be significant differences for the overall and subtests scores of the CRTT-Mandarin between the normal and PWA groups. The results confirmed the prediction. The same situation was also observed with the CCAT results. Further, the range of scores did not overlap between groups for the subtests or the overall scores for either test for except for subtests I, VI, IX, and X on the CRTT-Mandarin, and subtest 1 to 8 on the CCAT. While this suggests some level of specificity for detecting language differences between the groups on these measures, it does not provide an adequate evaluation of sensitivity because the CCAT did not provide a challenge for the normal group. Indeed, all normal participants produced maximum (ceiling) scores on five of the nine subtests, and most participants produced ceiling (score of 12.00) scores on all other subtests.

There was a ceiling effect for the CCAT for many subtests for the normal group and for one subtest for the PWA. Because most participants received the maximum score of 12, the scores could not be ranked, and correlations could not be computed. There were several possible reasons for this result in the PWA. First, the object-to-picture matching subtest does not assess language. A similar result was found when the RTT was compared to the PICA. That is, subtest XI (object-to-picture matching) of the PICA did not correlate highly with the RTT overall score (r= 0.11) for the PWA (McNeil & Prescott, 1978). The object-to-picture matching subtest did not correlate highly with any subtests or with the overall score of the CRTT-Mandarin in the PWA or the normal group. This task is considered a non-dominant hemisphere task

(Johnson & Porch, 1968; Porch, 1971a), and is generally considered to be a non-linguistic test. However, picture-to-object matching is frequently assessed on aphasia tests such as the PICA, WAB, and BDAE and is included to screen out general cognitive impairments and visual perceptual impairments, frequently associated with non-dominant hemisphere impairments.

Along with picture-to-object matching, a ceiling effect was also observed in the confrontation naming, sentence repetition, copying figures, and writing in simple sentence and directions subtests on the CCAT for the normal group. Because the CCAT is an aphasia language assessment tool and not designed for normal language assessment, it might be expected to be too easy for normal participants. Additionally, the small sample size may not represent the distribution of the normal population. However, because the majority of PWA did not perform near ceiling levels and their scores did not tend to overlap with the lower range of scores generated by the normal participants, the CCAT does appear to present an adequate range of difficulty to differentiate the two groups. However it might not be sensitive to severity of impairment.

4.2 CORRELATIONS

The results did not support the predictions underlying the second research question that asked whether there would be significant ($p < .05$) and high ($r > .70$) correlation coefficients between the CRTT-Mandarin Chinese overall and subtest scores and each of the CCAT subtest and overall scores for the normal participants and for the participants with aphasia. The reason for this result is the small sample size and the lack of score distribution particularly for the normal participants. The 11 PWA and 19 normal control group did not provide an adequate representation of the population and produced a restricted range of scores in both groups. When the PWA and the normal group were combined, the results between the CRTT-

Mandarin and CCAT correlations ranged from .62 to .85 with an overall correlation of r=. 75. In addition, the correlations of the CRTT-Mandarin efficiency and the CCAT ranged from .57 to .83 with an overall of .75. When analyzed together, the majority of the correlations reached the .70 criterion and was generally moderate to high.

The overall score on the CRTT for English speaking participants in the McNeil et al. (2010) study collected with a touch screen was higher than the results in the present study for both groups. Experience using the mouse to access the responses could be the cause for the lower scores of the participants in both groups than those realized in the McNeil et al. study (2010). Some of the participants in the current study may not have had experience using a mouse before their participation in the current study. For that reason, their performance may not fully or accurately represent their auditory comprehension on these subtests. Although systematic data were not collected in either study, participants reported fatigue more often when they were doing the CRTT-Mandarin than in the previous study done by McNeil et al (2010). In the current study, most of the PWA asked for a break after two to three subtests. Although the participants in the normal group did not ask for a break during the CRTT-Mandarin administration, they often reported fatigue after they finished the entire test. Unstructured interviews with the participants suggested that several got tired because they needed to concentrate and memorized the commands; some felt anxiety, some indicated that it was hard to control the mouse with their left hand. Furthermore, previous research also has shown that scores via the touch screen access method were significantly higher than the scores via the mouse access method on the CRTT (Heilman et al., 2008; McNeil et al. 2010). Therefore, future research should consider the participant's skills using the computer mouse compared to a touch screen and cultural differences, and other possible factors.

A higher correlation coefficient does mean a higher degree of association and higher accuracy of prediction between two variables (Schiavetti and Metz, 2006). Therefore, when individual's scores on the CCAT were higher, the scores on the CRTT-Mandarin tended to also be higher with above 50% shared variance (r= .75). Concurrent validity for the RTT was established with the overall score of the PICA correlated with the overall score of the RTT and yielded a correlation of 0.67 (McNeil & Prescott, 1978), and .81 for the computerized version (McNeil et al, 2010). Compared to the overall of the CCAT and the CRTT-Mandarin with the two groups combined, the correlation coefficient was 0.75, which was interpreted as an acceptable level for concurrent validity. It should also be mentioned that the correlation between the PICA and the CRTT for the normal participants was also very low (.39) and accounted for less than 7% of the shared variance between the tests.

4.3 CONCLUSION

The main conclusions of this study are as follows. The CRTT-Mandarin can be used to distinguish aphasic from normal language comprehension. Second, there are now preliminary psychometric data on the CRTT-Mandarin with respect to concurrent validity.

4.4 LIMITATIONS

The main limitation of the study was the small sample size in both groups. Although moderate to high correlations were observed when the analysis was collapsed across groups, these correlations cannot be used to infer outcomes for the distinct experimental groups. Also, the experimental error whereby the pretest of

the CRTT-Mandarin was not administered to some participants may have added variability to the data.

Another limitation may have been the access method for the response. The study did not compare the computer touch screen to the mouse. The response access method used in this study might have increased the processing load for these participants. Some data support this speculation. According to a government report from Taiwan (2009), in a national sample of normal individuals, 48.4% of people age 51-60 have had some experience using computers, while only 31% among 61 to 64 year-olds, and 12.9% among individuals 65 and above have had some experience using computers. The report also summarized important differences in computer use and literacy across urban versus rural settings. Participants from metropolitan areas reported greater use of computers than those from rural areas. Socioeconomic status and access to computer resources were likely relevant factors underlying these differences. The present study did not address these potentially confounding variables. Further research will be required in order to address these limitations and generalize current findings across dialect, age and socioeconomic groups.

The third limitation was that most judges and participants noticed that the stimuli in subtest IX and subtest X on the CRTT-Mandarin were grammatically correct and intelligible but idiomatically atypical. The limitation in these two subtests is language difference. The sentence structures are not exactly the same between these two languages. However, because every participant responded to the same stimuli, all participants were still in the same controlled environments. Moreover, the normal participants and PWA had relatively higher scores on subtest XI and X on the CRTT-Mandarin, which means participants still were able to respond to and comprehend the stimuli.

4.5 FUTURE RESEARCH

Future research is needed, but these data provide a first step toward the development of a valid and standardized test for Mandarin speaking persons with aphasia that can be used across languages. It is hoped that the future work will establish additional concurrent validity, establish test-retest and serial reliabilities, and other psychometric data for the test in PWA and in a representative normal group of participants. Future research should also investigate the performance with different response access methods in order to understand which response access method will be more appropriate to use with this population.

APPENDIX A

A.1 SUBJECT HISTORY (NORMAL)

Subject #(個案#)_____ Birth date (生日): _____

Age (年紀): _____Highest Education level (最高學歷):_____

1. Yes No: Did you have any brain damage, cognitive or psychiatric disorders before? If yes, explain and stop answering here:_____ 你有過任何腦部損傷、認知或是心理障礙嗎？ 如果有，請說明，並停止作答：_____

2. Yes No: Have you ever had any kind of speech, language or learning problem before? If yes, explain and you may stop answering here:_____ 你有過任何的語言、言語，或者是學習障礙嗎？如果有，請說明並停止作答：_____

3. Yes No: Did you ever have treatment for a speech or language impairment before? If yes, explain and stop answering here:_____ 你有過任何語言治療或是言語治療嗎？如果有，請說明並停止作答：_____

4. Yes No: Do you have any vision deficits that might affect your participation in this study? If yes, explain:_____ 你有任何視覺障礙可能會影響你參與此研究嗎？如果有，請說明:_____

5. Yes No: Do you need glasses to participate the study? 你需要戴眼鏡才能辦法參與此研究嗎?

6. Yes No: Do you have difficulty hearing? If yes, do you wear a hearing aid? Bilateral/ Right / Left / NA 你是否覺得聽力困難嗎? 例：覺得聽不清楚或是很吃力？如果是，你需要戴助聽器嗎？兩耳/右耳/左耳/不知道
7. Yes No: Is Mandarin Chinese your native language? If no, what is the primary language spoken in your home? _____ 中文是你的母語嗎？如果不是，哪種語言是你在家最常使用的語言？_____
8. Right Left either hand equally: Which hand is used to write and eat? 你用哪一手吃飯和寫字？_____

History of Bilingualism

雙語使用問卷調查

Paradis, M., & Libben, G. (1987). *The assessment of bilingual aphasia*: Lawrence Erlbaum Associates.

Subject #(個案#)_____ Age(年紀): _____ Highest Education level(最高學歷):_____

1. What is your date of birth? _____
   你的生日是?
2. Where were you born? _____
   你的出生地是?
3. As a child, what language did you speak most at home?_____
   在你小的時候，你在家最常說的語言是?
4. As a child, did you speak any other language at home? + - 0
   在你小的時候，你在家還有說其他的語言嗎?
5. What other languages did you speak at home as a child?_____
   在你小的時候，你在家還有說哪些語言?
6. What was your father's native language?_____
   你父親的母語是?
7. Did he speak any other language? + - 0
   他有說其他的語言嗎?

   *** If the answer to (7) is "no" then go to question (12)

   如果第 7 題的答案是「否」，請跳至第 12 題作答
8. What was your father's other language?_____
   你父親還說哪些語言?
9. What language did you father speak most to you at home?_____
   你父親在家最常用哪種語言跟你說話?
10. Did your father speak any other languages at home?_____ + - 0
    你父親在家會用其他語言嗎?

    *** If the answer to (10) is "no" then go to question (12)

    如果第 10 題答案為「否」，請跳至第 12 題作答

11. What other language did your father speak at home? _____
你父親在家還說哪些語言?

12. What was your mother's native language?_____
你母親的母語是?

13. Did she speak any other language? + - 0
她還有說其他語言嗎?

*** If the answer to (13) is "no" then go to question (18)

如果第 13 題答案為「否」，請跳至第 18 題作答

14. What was your mother's other language(s)?_____
你母親還說哪些語言?

15. What language did your mother speak most to you at home?_____
你母親在家最常用哪種語言跟你說話?

16. Did your mother speak any other languages at home? + - 0
你母親在家會用其他語言嗎?

*** If the answer to (16) is "no" then go to question (18)

如果第 16 題答案為「否」，請跳至第 18 題作答

17. What other languages did your mother speak at home?_____
你母親在家還說哪些語言?

18. Did anyone else take care of your as a child? + - 0
在你小時候，除了父母外，你還有其他的照顧者嗎?

*** If the answer to (18) is "no" then go to question (25)

如果第 18 題答案為「否」，請跳至第 25 題作答

19. What was his/her native language?_____
他/她的母語是?

20. Did he/she speak any other languages? + - 0
他/她還有說其他的語言嗎?

*** If the answer to (20) is "no" then go to question (25)

如果第 20 題答案為「否」，請跳至第 25 題作答

21. What was his/her other language(s)?_____
他/她還說哪些語言?

22. What language did he/she speak most to you at home?_____
他/她在家最常用哪種語言跟你說話?

23. Did he/she speak any other languages at home? + - 0
他/她在家會用其他語言嗎?

*** If the answer to (23) is "no" then go to question (25)

如果第 23 題答案為「否」，請跳至第 25 題作答

24. What other languages did he/she speak at home?_____
他/她在家還說哪些語言?

25. What languages did you speak most with friends as a child?_____
在你小的時候，你最常用哪種語言跟你的朋友說話？

26. How many years of education have you had? _____
你受過幾年的教育?

27. When you started school what was the language of instruction?_____
當你開始上學的時候，學校使用哪種語言?

28. At that time, did you take any subjects in another language? + - 0
在那段時間內，你有上任何的課是使用其他語言的嗎?

*** If the answer to (28) is "no" then go to question (30)

如果第 28 題答案為「否」，請跳至第 30 題作答

29. What were the other languages of instruction?_____
學校裡還使用哪些其他的語言?

30. What language did most of the other students speak at this school?_____
在那個學校，大部分的學生都使用哪種語言?

31. Did you change to a school with another language of instruction after that? + - 0
在那個學校之後，你有到任何其他學校是使用不同語言的嗎?

*** If the answer to (31) is "no" then go to question (49)

如果第 31 題答案為「否」，請跳至第 49 題作答

32. What was this language?_____
哪種不同的語言?

33. After how many years did you switch to this new language of instruction?_____
在你從前一個學校畢業之後多少年，你才到這個需要使用不同語言的學校?

34. At that time did you take any subjects in another language? + - 0
在那段時間內，你有上任何的課是使用其他語言的嗎?

*** If the answer to (34) is "no" then go to question (36)

如果第 34 題答案為「否」，請跳至第 36 題作答

35. What were the other languages of instruction?_____
學校裡還使用哪些其他的語言?

36. What language did most of the other students speak at this school?_____
在那個學校，大部分的學生都使用哪種語言?

37. Did you change to a school with another language of instruction after that? + - 0
在那個學校之後，你有到任何其他學校是使用不同語言的嗎?

*** If the answer to (37) is "no" then go to question (49)

如果第 37 題答案為「否」，請跳至第 49 題作答

38. What was this language?_____
哪種不同的語言?

39. After how many years did you switch to this new language of instruction?_____
在你從前一個學校畢業之後多少年，你才到這個需要使用不同語言的學校?

40. At that time, did you take any subjects in another language?_____
在那段時間內，你有上任何的課是使用其他語言的嗎?

41. What were the other languages of instruction?_____
學校裡還使用哪些其他的語言?

42. What language did most of the other students speak at this school?_____
在那個學校，大部分的學生都使用哪種語言?

43. Did you change to a school with a different language of instruction after that? + - 0
在那個學校之後，你有到任何其他學校是使用不同語言的嗎?

*** If the answer to (43) is "no" then go to question (49)

如果第 43 題答案為「否」，請跳至第 49 題作答

44. What was this language? _____
哪種不同的語言?

45. After how many years did you switch to this new language of instruction?_____
在你從前一個學校畢業之後多少年，你才到這個需要使用不同語言的學校?

46. After that time, did you take any subjects in another language?_____
在此之後，你有上過任何需要使用其他語言的課嗎?

47. What were the other languages of instruction?_____

學校裡還使用哪些其他的語言?

48. What language did most of the other students speak at this school?_____
在那個學校，大部分的學生都使用哪種語言?

49. And after your education was completed, what was your occupation?_____
在你完成學業之後，你的職業是?

50. Before your accident/illness what languages were you able to speak?_____
在這次生病之前，你可以說哪些語言?

Table 20 Summary of medical history in normal participants

Subject	**N1**	**N2**	**N3**	**N4**	**N5**	**N6**	**N7**	**N8**	**N9**	**N10**	**N11**
Gender	F	M	M	F	F	F	F	M	M	F	M
Age	50	54	45	42	50	49	57	60	68	63	46
1. Did you have any brain damage, cognitive or psychiatric disorders before?	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**
2. Have you ever had any kind of speech, language or learning problem before ?	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**
3. Did you ever have treatment for a speech or language impairment before?	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**
4. Do you have any vision deficits that might affect your participation in this study?	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**
5. Do you need glasses to participate the study?	**N**	**Y**	**N**	**N**	**N**	**Y**	**Y**	**Y**	**Y**	**Y**	**N**
6. Do you have difficulty hearing? Do you wear a hearing aid? Bilateral/ Right / Left / NA	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**
7. Is Mandarin Chinese your native language?	**Y**	**Y**	**N**	**N**	**N**	**N**	**Y**	**Y**	**Y**	**Y**	**N**
8. Which hand is used to write and eat? Right Left Either hand equally	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**

Y: yes, N: no, R: right, L: left

Table 20 (continued)

Subject	**N12**	**N13**	**N14**	**N15**	**N16**	**N17**	**N18**	**N19**			
Gender	M	M	M	M	F	M	F	M			
Age	48	42	55	57	41	46	42	46			
1. Did you have any brain damage, cognitive or psychiatric disorders before?	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**			
2. Have you ever had any kind of speech, language or learning problem before?	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**			
3. Did you ever have treatment for a speech or language impairment before?	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**			
4. Do you have any vision deficits that might affect your participation in this study?	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**			
5. Do you need glasses to participate the study?	**Y**	**N**	**N**	**Y**	**N**	**Y**	**N**	**Y**			
6. Do you have difficulty hearing? Do you wear a hearing aid? Bilateral/ Right / Left / NA	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**			
7. Is Mandarin Chinese your native language?	**N**	**N**	**Y**	**N**	**Y**	**N**	**N**	**N**			
8. Which hand is used to write and eat? Right Left Either hand equally	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**			

Y: yes, N: no, R: right, L: left

Table 21 Summary of history of bilingualism in normal participants

Subject	**N1**	**N2**	**N3**	**N4**	**N5**	**N6**	**N7**	**N8**	**N9**	**N10**	**N11**
Gender	F	M	M	F	F	F	F	M	M	F	M
Age	50	54	45	42	50	49	57	60	68	63	46
1. As a child, what language did you speak most at home?	**H**	**M**	**T**	**T**	**T**	**T**	**M**	**M**	**M**	**M**	**H**
2. As a child did you speak any other language at home?	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**
3. What was your father's native language?	**H**	**M**	**T**	**T**	**T**	**T**	**M**	**M**	**M**	**M**	**H**
4. What was your mother's native language?	**H**	**M**	**T**	**T**	**T**	**T**	**M**	**M**	**M**	**M**	**H**
5. What languages did you speak most with friends as a child?	**H**	**M**	**T**	**T**	**T**	**T**	**M**	**M**	**M**	**M**	**H**
6. When you started school, what was the language of instruction?	M	M	M	M	M	M	M	M	M	M	M
7. Did you change to a school with another language of instruction after that?	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**
8. What was the language of the instruction?	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
9. What language you do speak also?	T										

M: Mandarin; T: Taiwanese; H: Hakka; Y: yes, N: no

Table 21 (continued)

Subject	**N12**	**N13**	**N14**	**N15**	**N16**	**N17**	**N18**	**N19**			
Gender	M	M	M	M	F	M	F	M			
Age	48	42	55	57	41	46	42	46			
1. As a child, what language did you speak most at home?	**H**	**H**	**M**	**T**	**M**	**T**	**T**	**T**			
2. As a child did you speak any other language at home?	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**			
3. What was your father's native language?	**H**	**H**	**M**	**T**	**M**	**T**	**T**	**T**			
4. What was your mother's native language?	**H**	**H**	**M**	**T**	**M**	**T**	**T**	**T**			
5. What languages did you speak most with friends as a child?	**H**	**H**	**M**	**T**	**M**	**T**	**T**	**T**			
6. When you started school, what was the language of instruction?	M	M	M	M	M	M	M	M			
7. Did you change to a school with another language of instruction after that?	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**			
8. What was the language of the instruction?	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a			
9. What language you do speak also?											

M: Mandarin; T: Taiwanese; H: Hakka; Y: yes, N: no

A.2 SUBJECT HISTORY (PWA)

Subject #(個案#)_____ Birth date (生日): _____

Age (年紀): _____ Highest Education level (最高學歷):_____

1. Yes No: Is this stroke your first stroke? If no, you may stop answering here. 這是你第一次中風嗎? 如果不是，請停止作答
2. Yes No: Did you have any brain damage, cognitive or psychiatric disorders before your stroke? If yes, explain and stop answering here:_____ 在這次中風前，你有過任何腦部損傷、認知或是心理障礙嗎？ 如果有，請說明，並停止作答：

   _____
3. When did you have this stroke? _____(month/year)_你什麼時候中風的？ _____(年/月)
4. Yes No: Have you ever had any kind of speech, language or learning problem before the stroke? If yes, explain and you may stop answering here:_____ 在這次中風之前，你有過任何的語言、言語，或者是學習障礙嗎？如果有，請說明並停止作答：_____
5. Yes No: Did you ever have treatment for a speech or language impairment before your stroke? If yes, explain and stop answering here:_____ 在這次中風之前，你有過任何語言治療或是言語治療嗎？如果有， 請說明並停止作答：

   _____

6. Yes No: Do you have any vision deficits that might affect your participation in this study? If yes, explain:_____ 你有任何視覺障礙可能會影響你參與此研究嗎？如果有，請說明:_____

7. Yes No: Do you need glasses to participate the study? 你需要戴眼鏡才能辦法參與此研究嗎?

8. Yes No: Do you have difficulty hearing? If yes, do you wear a hearing aid? Bilateral/ Right / Left / NA 你是否覺得聽力困難嗎? 例：覺得聽不清楚或是很吃力？如果是，你需要戴助聽器嗎？ 兩耳/右耳/左耳/不知道

9. Yes No: Is Mandarin Chinese your native language? If no, what is the primary language spoken in your home? _____中文是你的母語嗎？ 如果不是，哪種語言是你在家最常使用的語言？_____

10. Right Left either hand equally: Which hand is used to write and eat before stroke? 你用哪一手吃飯和寫字？

History of Bilingualism

雙語使用問卷調查

Paradis, M., & Libben, G. (1987). *The assessment of bilingual aphasia*: Lawrence Erlbaum Associates.

Subject #(個案#)_____ Age(年紀): _____ Highest Education level(最高學歷):_____

1. What is your date of birth? _____
   你的生日是?
2. Where were you born? _____
   你的出生地是?
3. As a child, what language did you speak most at home?_____
   在你小的時候，你在家最常說的語言是?
4. As a child, did you speak any other language at home? + - 0
   在你小的時候，你在家還有說其他的語言嗎?
5. What other languages did you speak at home as a child?_____
   在你小的時候，你在家還有說哪些語言?
6. What was your father's native language?_____
   你父親的母語是?
7. Did he speak any other language? + - 0
   他有說其他的語言嗎?

   *** if the answer to (7) is "no" then go to question (12)

   如果第 7 題的答案是「否」，請跳至第 12 題作答
8. What was your father's other language?_____
   你父親還說哪些語言?
9. What language did you father speak most to you at home?_____
   你父親在家最常用哪種語言跟你說話?
10. Did your father speak any other languages at home?_____ + - 0
    你父親在家會用其他語言嗎?

    *** if the answer to (10) is "no" then go to question (12)

如果第 10 題答案為「否」，請跳至第 12 題作答

11. What other language did your father speak at home? _____
你父親在家還說哪些語言?

12. What was your mother's native language?_____
你母親的母語是?

13. Did she speak any other language? + - 0
她還有說其他語言嗎?

*** If the answer to (13) is "no" then go to question (18)

如果第 13 題答案為「否」，請跳至第 18 題作答

14. What was your mother's other language(s)?_____
你母親還說哪些語言?

15. What language did your mother speak most to you at home?_____
你母親在家最常用哪種語言跟你說話?

16. Did your mother speak any other languages at home? + - 0
你母親在家會用其他語言嗎?

*** If the answer to (16) is "no" then go to question (18)

如果第 16 題答案為「否」，請跳至第 18 題作答

17. What other languages did your mother speak at home?_____
你母親在家還說哪些語言?

18. Did anyone else take care of your as a child? + - 0
在你小時候，除了父母外，你還有其他的照顧者嗎?

*** If the answer to (18) is "no" then go to question (25)

如果第 18 題答案為「否」，請跳至第 25 題作答

19. What was his/her native language?_____
他/她的母語是?

20. Did he/she speak any other languages? + - 0
他/她還有說其他的語言嗎?

*** If the answer to (20) is "no" then go to question (25)

如果第 20 題答案為「否」，請跳至第 25 題作答

21. What was his/her other language(s)?_____
他/她還說哪些語言?

22. What language did he/she speak most to you at home?_____
他/她在家最常用哪種語言跟你說話?

23. Did he/she speak any other languages at home? + - 0
他/她在家會用其他語言嗎?

*** If the answer to (23) is "no" then go to question (25)

如果第 23 題答案為「否」，請跳至第 25 題作答

24. What other languages did he/she speak at home?_____
他/她在家還說哪些語言?

25. What languages did you speak most with friends as a child?_____
在你小的時候，你最常用哪種語言跟你的朋友說話？

26. How many years of education have you had? _____
你受過幾年的教育?

27. When you started school what was the language of instruction?_____
當你開始上學的時候，學校使用哪種語言?

28. At that time, did you take any subjects in another language? + - 0
在那段時間內，你有上任何的課是使用其他語言的嗎?

*** If the answer to (28) is "no" then go to question (30)

如果第 28 題答案為「否」，請跳至第 30 題作答

29. What were the other languages of instruction?_____
學校裡還使用哪些其他的語言?

30. What language did most of the other students speak at this school?_____
在那個學校，大部分的學生都使用哪種語言?

31. Did you change to a school with another language of instruction after that? + - 0
在那個學校之後，你有到任何其他學校是使用不同語言的嗎?

*** If the answer to (31) is "no" then go to question (49)

如果第 31 題答案為「否」，請跳至第 49 題作答

32. What was this language?_____
哪種不同的語言?

33. After how many years did you switch to this new language of instruction?_____
在你從前一個學校畢業之後多少年，你才到這個需要使用不同語言的學校?

34. At that time did you take any subjects in another language? + - 0
在那段時間內，你有上任何的課是使用其他語言的嗎?

*** If the answer to (34) is "no" then go to question (36)

如果第 34 題答案為「否」，請跳至第 36 題作答

35. What were the other languages of instruction?_____
學校裡還使用哪些其他的語言?

36. What language did most of the other students speak at this school?_____
在那個學校，大部分的學生都使用哪種語言?

37. Did you change to a school with another language of instruction after that? + - 0
在那個學校之後，你有到任何其他學校是使用不同語言的嗎?

*** If the answer to (37) is "no" then go to question (49)

如果第 37 題答案為「否」，請跳至第 49 題作答

38. What was this language?_____
哪種不同的語言?

39. After how many years did you switch to this new language of instruction?_____
在你從前一個學校畢業之後多少年，你才到這個需要使用不同語言的學校?

40. At that time, did you take any subjects in another language?_____
在那段時間內，你有上任何的課是使用其他語言的嗎?

41. What were the other languages of instruction?_____
學校裡還使用哪些其他的語言?

42. What language did most of the other students speak at this school?_____
在那個學校，大部分的學生都使用哪種語言?

43. Did you change to a school with a different language of instruction after that? + -0
在那個學校之後，你有到任何其他學校是使用不同語言的嗎?

*** If the answer to (43) is "no" then go to question (49)

如果第 43 題答案為「否」，請跳至第 49 題作答

44. What was this language? _____
哪種不同的語言?

45. After how many years did you switch to this new language of instruction?_____
在你從前一個學校畢業之後多少年，你才到這個需要使用不同語言的學校?

46. After that time, did you take any subjects in another language?_____
在此之後，你有上過任何需要使用其他語言的課嗎?

47. What were the other languages of instruction?_____
學校裡還使用哪些其他的語言?

48. What language did most of the other students speak at this school?_____
在那個學校，大部分的學生都使用哪種語言?

49. And after your education was completed, what was your occupation?_____
在你完成學業之後，你的職業是?

50. Before your accident/illness what languages were you able to speak?_____
在這次生病之前，你可以說哪些語言?

Table 22 Summary of medical history in PWA

Subject	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11
Gender	M	M	M	F	M	M	M	F	M	M	M
Age	50	41	40	41	42	80	51	45	48	54	63
1. Is this stroke your first stroke?	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**
2. Did you have any brain damage, cognitive or psychiatric disorders before your stroke?	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**
3. Post onset time	**6y**	**4y**	**3y**	**1m**	**3m**	**1y**	**6y**	**4y**	**3m**	**2y**	**2y**
4. Have you ever had any kind of speech, language or learning problem before the stroke?	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**
5. Did you ever have treatment for a speech or language impairment before your stroke?	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**
6. Do you have any vision deficits that might affect your participation in this study?	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**
7. Do you need glasses to participate the study?	**Y**	**Y**	**Y**	**Y**	**N**	**N**	**N**	**N**	**N**	**N**	**Y**
8. Do you have difficulty hearing? Do you wear a hearing aid? Bilateral/ Right / Left / NA	**N**	**N**	**N**	**N**	**N**	**N/A**	**N**	**N**	**N**	**N**	**N**
9. Is Mandarin Chinese your native language?	**N**	**N**	**Y**	**N**	**N**	**N**	**N**	**Y**	**Y**	**Y**	**N**
10. Which hand is used to write and eat? Right Left Either hand equally	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**	**R**

Y: yes, N: no, R: right, L: left

Table 23 Summary of history of bilingualism in PWA

Subject	**A1**	**A2**	**A3**	**A4**	**A5**	**A6**	**A7**	**A8**	**A9**	**A10**	**A11**
Gender	M	M	M	F	M	M	M	F	M	M	M
Age	50	41	40	41	42	80	51	45	48	54	63
1. As a child, what language did you speak most at home?	**T**	**T**	**M**	**T**	**T**	**T**	**T**	**M**	**M**	**M**	**T**
2. As a child did you speak any other language at home?	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**
3. What was your father's native language?	**T**	**T**	**M**	**T**	**T**	**T**	**T**	**M**	**M**	**M**	**T**
4. What was your mother's native language?	**T**	**T**	**M**	**T**	**T**	**T**	**T**	**M**	**M**	**M**	**T**
5. What languages did you speak most with friends as a child?	**T**	**T**	**M**	**T**	**T**	**T**	**T**	**M**	**M**	**M**	**T**
6. When you started school, what was the language of instruction?	M	M	M	M	M	J	M	M	M	M	M
7. Did you change to a school with another language of instruction after that?	**N**	**N**	**N**	**N**	**N**	**Y**	**N**	**N**	**N**	**N**	**N**
8. What was the language of the instruction?	n/a	n/a	n/a	n/a	n/a	M	n/a	n/a	n/a	n/a	n/a
9. What language you do speak also?											

APPENDIX B

THE COMMANDS AGREEMENT SURVEY

Subject #_____ Birth date: _____ Age: _____ Highest Education level: _____

Primary language:_____ Dialect:_____

Part one: Written statement command review

Instruction: There are several sentences I need you to read, and if you think the sentences are acceptable, please mark O in the box. If it is not acceptable, please mark X in the box. “Acceptable means that the sentence will not affect your answer to the commands.

Part two: Auditory statement command review

Instruction: There are several sentences I need you to listen to. If you think that the sentences sound natural and without any articulation errors, please mark O in the box. If you think the sentences are not natural or not clear, please mark X in the box

.

Part one: Written the statement commands review

前測說明(Pretest)

English commands	Chinese commands	Cues
1. Can you see all of these objects on the screen? 1-1, (prompt) These are all circles. 1-2, (prompt) These are all squares.	你能看到螢幕上所有的圖案嗎? 這些都是圓形 這些都是方形	
2. I want you to touch any circle. These are all circles.	請指出其中一個圓形 這些都是圓形	
3. Now touch any square. These are all squares.	現在指出其中一個方形 這些都是方形	
4. Now touch any little square. These are all little squares.	現在指出其中一個小方形 這些都是小方形	
5. Now touch any big square. These are all big squares	現在指出其中一個大方形 這些都是大方形	
6. Now touch any little circle. These are all little circles	現在指出其中一個小圓形 這些都是小圓形	
7. Now touch any big circle. These are all big circles	現在指出其中一個大圓形 這些都是大圓形	

8.1 Now touch two things that are blue (x2) These are all blue 8.2 Now touch two things that are green (x2) These are all green 8.3 Now touch two things that are red (x2) These are all red 8.4 Now touch two things that are white. (x2) These are all white. 8.5 Now touch two things that are black.(x2) These are all black	現在指出兩個藍色的圖案 這些都是藍色 現在指出兩個綠色的圖案 這些都是綠色 現在指出兩個紅色的圖案 這些都是紅色 現在指出兩個白色的圖案 這些都是白色 現在指出兩個黑色的圖案 這些都是黑色	
9. Look at these blinking objects. Now move one to the other. ROMPT=This is a move.	請看這些閃爍的圖形，請移動其中一個圖形到另一個的旁邊 這樣表示移動的意思	
I am going to ask you to do may different things with these. Some of them may be hard and some will be easy, but I want you to listen carefully and do exactly what I say…are you ready?	接下來，我會請你做很多不一樣的題目，這些題目有的比較難，有的比較簡單。我要你注意聽，並且完全照題目做答，你準備好了嗎	

這是測驗一

English commands . This is part one.	Chinese commands	Cues
1. Touch the black circle.	指出黑色圓形。	我要你指黑色圓形
2. Touch the red circle.	指出紅色圓形。	我要你指紅色圓形
3. Touch the blue square.	指出藍色方形。	我要你指藍色方形
4. Touch the green square.	指出綠色方形。	我要你指綠色方形
5. Touch the white circle.	指出白色圓形。	我要你指白色圓形
6. Touch the green circle.	指出綠色圓形。	我要你指綠色圓形
7. Touch the black square.	指出黑色方形。	我要你指黑色方形
8. Touch the white square.	指出白色方形。	我要你指白色方形
9. Touch the blue circle.	指出藍色圓形。	我要你指藍色圓形
10. Touch the red square.	指出紅色方形	我要你指紅色方形

這是測驗二

English commands . This is part two.	Chinese commands	Cues
1. Touch the big green circle.	指出大的綠色圓形。	我要你指大的綠色圓形
2. Touch the big black circle.	指出大的黑色圓形。	我要你指大的黑色圓形
3. Touch the little blue square.	指出小的藍色方形。	我要你指小的藍色方形
4. Touch the big red square.	指出大的紅色方形。	我要你指大的紅色方形
5. Touch the little red circle.	指出小的紅色圓形。	我要你指小的紅色圓形
6. Touch the little green square.	指出小的綠色方形。	我要你指小的綠色方形
7. Touch the little white square.	指出小的白色方形。	我要你指小的白色方形
8. Touch the big white circle.	指出大的白色圓形。	我要你指大的白色圓形
9. Touch the big blue circle.	指出大的藍色圓形。	我要你指大的藍色圓形
10. Touch the little black square.	指出小的黑色方形。	我要你指小的黑色方形
.		

這是測驗三

English commands . This is part three.	Chinese commands	Cues
1. Touch the green square and the black square.	指出綠色方形和黑色方形。	我要你先指出綠色方形再指出黑色方形
2. Touch the blue circle and the green square.	指出藍色圓形和綠色方形。	我要你先指出藍色圓形再指出綠色方形
3. Touch the white circle and the blue square.	指出白色圓形和藍色方形。	我要你先指出白色圓形再指出藍色方形
4. Touch the black circle and the white square.	指出黑色圓形和白色方形。	我要你先指出黑色圓形再指出白色方形
5. Touch the green circle and the red square.	指出綠色圓形和紅色方形。	我要你先指出綠色圓形再指出紅色方形
6. Touch the red square and the white circle.	指出紅色方形和白色圓形。	我要你先指出紅色方形再指出白色圓形
7. Touch the white square and the green circle.	指出白色方形和綠色圓形。	我要你先指出白色方形再指出綠色圓形
8. Touch the black square and the red circle.	指出黑色方形和紅色圓形。	我要你先指出黑色方形再指出紅色圓形
9. Touch the red circle and the white circle.	指出紅色圓形和白色圓形。	我要你先指出紅色圓形再指出白色圓形
10. Touch the blue square and the black circle.	指出藍色方形和黑色圓形。	我要你先指出藍色方形再指出黑色圓形

這是測驗四

English commands . This is part four.	Chinese commands	Cues
1. Touch the big green square and the little black square	指出大的綠色方形和小的黑色方形。	我要你先指出大的綠色方形再指出小的黑色方形
2. Touch the big black square and the little red circle	指出大的黑色方形和小的紅色圓形。	我要你先指出大的黑色方形再指出小的紅色圓形
3. Touch the big blue circle and the little green square.	指出大的藍色圓形和小的綠色方形。	我要你先指出大的藍色圓形再指出小的綠色方形
4. Touch the big white circle and the little blue square.	指出大的白色圓形和小的藍色方形。	我要你先指出大的白色圓形再指出小的藍色方形
5. Touch the little blue square and the big black square.	指出小的藍色方形和大的黑色方形。	我要你先指出小的藍色方形再指出大的黑色方形
6. Touch the little green circle and the big red square.	指出小的綠色圓形和大的紅色方形。	我要你先指出小的綠色圓形再指出大的紅色方形
7. Touch the little black circle and the little white square.	指出小的黑色圓形和小的白色方形。	我要你先指出小的黑色圓形再指出小的白色方形
8. Touch the little white square and the big green circle.	指出小的白色方形和大的綠色圓形。	我要你先指出小的白色方形再指出大的綠色圓形
9. Touch the little red circle and the big blue circle.	指出小的紅色圓形和大的藍色圓形。	我要你先指出小的紅色圓形再指出大的藍色圓形
10. Touch the big red square and the big white circle.	指出大的紅色方形和大的白色圓形。	我要你先指出大的紅色方形再指出大的白色圓形

這是測驗五

English commands . This is part five.	Chinese commands	Cues
1. Put the black square by the red circle.	把黑色方形放在紅色圓形旁邊。	指出黑色方形然後把它放在紅色圓形旁邊
2. Put the black circle above the white square.	把黑色圓形放在白色方形上面。	指出黑色圓形然後把它放在白色方形上面
3. Put the blue square before the black circle.	把藍色方形放在黑色圓形前面。	指出藍色方形然後把它放在黑色圓形前面
4. Put the red circle on the blue circle.	把紅色圓形放在藍色圓形上面。	指出紅色圓形然後把它放在藍色圓形上面
5. Put the blue circle behind the green square.	把藍色圓形放在綠色方形後面。	指出藍色圓形然後把它放在綠色方形後面
6. Put the green square under the black square.	把綠色方形放在黑色方形下面。	指出綠色方形然後把它放在黑色方形下面
7. Put the white circle below the blue square.	把白色圓形放在藍色方形下面。	指出白色圓形然後把它放在藍色方形下面
8. Put the white square next to the green circle.	把白色方形放在綠色圓形旁邊。	指出白色方形然後把它放在綠色圓形旁邊
9. Put the red square in front of the white circle.	把紅色方形放在白色圓形前面。	指出紅色方形然後把它放在白色圓形前面
10. Put the green circle beside the red square.	把綠色圓形放在紅色方形旁邊。	指出綠色圓形然後把它放在紅色方形旁邊

這是測驗六

English commands . This is part six.	Chinese commands	Cues
1. Put the big red square in front of the big white circle.	把大的紅色方形放在大的白色圓形前面。	指出大的紅色方形然後把它放在大的白色圓形前面
2. Put the big blue circle before the little green square.	把大的藍色圓形放在小的綠色方形前面。	指出大的藍色圓形然後把它放在小的綠色方形前面
3. Put the little green circle under the big red square.	把小的綠色圓形放在大的紅色方形下面。	指出小的綠色圓形然後把它放在大的紅色方形下面。
4. Put the big black square above the little red circle.	把大的黑色方形放在小的紅色圓形上面。	指出大的黑色方形然後把它放在小的紅色圓形上面。
5. Put the little black circle below the little white square.	把小的黑色圓形放在小的白色方形下面。	指出小的黑色圓形然後把它放在小的白色方形下面。
6. Put the little blue square behind the big black circle.	把小的藍色方形放在大的黑色圓形後面。	指出小的藍色方形然後把它放在大的黑色圓形後面。
7. Put the big green square by the little black square.	把大的綠色方形放在小的黑色方形旁邊。	指出大的綠色方形然後把它放在小的黑色方形旁邊。
8. Put the big white circle next to the little blue square.	把大的白色圓形放在小的藍色方形旁邊。	指出大的白色圓形然後把它放在小的藍色方形旁邊。
9. Put the little red circle beside the big blue circle.	把小的紅色圓形放在大的藍色圓形旁邊。	指出小的紅色圓形然後把它放在大的藍色圓形旁邊。
10. Put the little white square on the big green circle.	把小的白色方形放在大的綠色圓形上面。	指出小的白色方形然後把它放在大的綠色圓形上面。

這是測驗七

English commands . This is part seven.	Chinese commands	Cues
1. Put the black circle to the left of the white square.	把黑色圓形放在白色方形左邊。	指出黑色圓形然後把它放在白色方形左邊。
2. Put the red square to the left of the white circle.	把紅色方形放在白色圓形左邊。	指出紅色方形然後把它放在白色圓形左邊。
3. Put the black square to the right of the red circle.	把黑色方形放在紅色圓形右邊。	指出黑色方形然後把它放在紅色圓形右邊。
4. Put the blue circle to the left of the green square.	把藍色圓形放在綠色方形左邊。	指出藍色圓形然後把它放在綠色方形左邊。
5. Put the green circle to the left of the red square.	把綠色圓形放在紅色方形左邊。	指出綠色圓形然後把它放在紅色方形左邊。
6. Put the white square to the right of the green circle.	把白色方形放在綠色圓形右邊。	指出白色方形然後把它放在綠色圓形右邊。
7. Put the red circle to the right of the blue circle.	把紅色圓形放在藍色圓形右邊。	指出紅色圓形然後把它放在藍色圓形右邊。
8. Put the white circle to the right of the blue square.	把白色圓形放在藍色方形右邊。	指出白色圓形然後把它放在藍色方形右邊。
9. Put the blue square to the left of the black circle.	把藍色方形放在黑色圓形左邊。	指出藍色方形然後把它放在黑色圓形左邊。
10. Put the green square to the right of the black square.	把綠色方形放在黑色方形右邊。	指出綠色方形然後把它放在黑色方形右邊。

這是測驗八

English commands . This is part eight.	Chinese commands	Cues
1. Put the little green circle to the left of the big red square.	把小的綠色圓形放在大的紅色方形左邊。	指出小的綠色圓形然後把它放在大的紅色方形左邊。
2. Put the big white circle to the left of the little blue square.	把大的白色圓形放在小的藍色方形左邊。	指出大的白色圓形然後把它放在小的藍色方形左邊。
3. Put the big green square to the right of the little black square.	把大的綠色方形放在小的黑色方形右邊。	指出大的綠色方形然後把它放在小的黑色方形右邊。
4. Put the little white square to the right of the big green circle.	把小的白色方形放在大的綠色圓形右邊。	指出小的白色方形然後把它放在大的綠色圓形右邊。
5. Put the big red square to the left of the big white circle.	把大的紅色方形放在大的白色圓形左邊。	指出大的紅色方形然後把它放在大的白色圓形左邊。
6. Put the little black circle to the left of the little white square.	把小的黑色圓形放在小的白色方形左邊。	指出小的黑色圓形然後把它放在小的白色方形左邊。
7. Put the little red circle to the right of the big blue square.	把小的紅色圓形放在大的藍色方形右邊。	指出小的紅色圓形然後把它放在大的藍色方形右邊。
8. Put the big black square to the right of the little red circle.	把大的黑色方形放在小的紅色圓形右邊。	指出大的黑色方形然後把它放在小的紅色圓形右邊。
9. Put the big blue circle to the left of the little green square.	把大的藍色圓形放在小的綠色方形左邊。	指出大的藍色圓形然後把它放在小的綠色方形左邊。
10. Put the little blue square to the left of the big black circle.	把小的藍色方形放在大的黑色圓形左邊。	指出小的藍色方形然後把它放在大的黑色圓形左邊。

這是測驗九

English commands . This is part nine.(see note!)	Chinese commands	Cues
1. Instead of the green square, touch the black square.	不要指出綠色方形，指出黑色方形。	Same as repeat (the command statement)
2. Unless you have touched the white square, touch the green circle.	除非你有指過白色方形，要不然就指出綠色圓形。	
3. If you have not touched the white circle, touch the blue square.	如果你還沒有指過白色圓形，就指藍色方形。	
4. Touch the green circle if you have not touched the red square.	指出綠色圓形，如果你還沒有指過紅色方形。	
5. Either touch the red square or the white circle.	指出紅色方形或是白色圓形。	
6. Touch the blue circle instead of the green square.	指出藍色圓形，不要指出綠色方形。	
7. Touch either the red circle or the blue circle.	指出紅色圓形或是藍色圓形。	
8. Touch the black square if there is a red circle.	指出黑色方形，如果有紅色圓形。	
9. Touch the blue square unless you have touched the black circle.	指出藍色方形，除非你已經指過黑色圓形	
10. If there is a black circle, touch the white square.	如果有黑色圓形，指出白色方形。	

這是測驗十

English commands . This is part ten.	Chinese commands	Cues
1. Touch the big black square unless you have touched the little red circle.	指出大的黑色方形, 除非你已經指過小的紅色圓形。	Same as repeat (the command statement)
2. Touch the little blue square if there is a big black circle.	指出小的藍色方形,如果有大的黑色圓形。	
3. Unless you have touched the little white square, touch the big green circle.	除非你有指過小的白色方形, 要不然就指出大的綠色圓形。	
4. If there is a big white circle, touch the little blue square.	如果有大的白色圓形, 指出小的藍色方形。	
5. Touch the big blue circle instead of the little green square.	指出小的綠色方形，不要指大的藍色圓形。	
6. Touch the little green circle if you have not touched the big red square.	指出小的綠色圓形, 如果你還沒有指過大的紅色方形。	
7. Touch either the big green square or the little black square	指出大的綠色方形或是小的黑色方形。	
8. Instead of the big red square touch the big white circle.	不要指大的紅色方形,指出大的白色圓形。	
9. If you have not touched the little black circle, touch the little white square.	如果你還沒有指過小的黑色圓形, 就指小的白色方形。	
10. Either touch the little red circle or the big blue circle.	指出小的紅色圓形或是大的藍色圓形。	

Cues for subtests: Cue codes are subtest item followed by 'C' (see examples below)

Cue: I want you to touch the… (Subtests I & II)

e.g. I1C = I want you to touch the black circle.

Cue: touch the…and put it… (Subtests V, IV, VII, & VIII)

e.g. V1C = Touch the black square and put it by the red circle.

Cue: I want you to first touch the…and then touch the…(Subtests III & IV)

e.g. III1C = I want you to first touch the green square and then touch the black square.

Cue: repeat the command statement (Subtests IX & X)

Note. In the subtest 9, the following instructions "This is part nine" should be given to the subject. But, in the CRTT, it was missed.

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